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TRACTION.

WELL, rumour was more or less right. There was a traction company in prospect, and it has come out. It has a strong board, the members of which are unimpeachable. Half of them, however, represent the vendors. There is no reason why they should not be good directors : they have a stake in the company, and if it proves successful it is greatly to their credit and profit. But they are hardly trustees so much for the money-finders as for themselves. We hope for their own sakes they will get back all which they have put into the two preceding companies and the firm ; and judging from the price charged, if they are able to take much of it in cash, it looks probable. Two hundred and forty-two thousand pounds is not a small sum ; it is sufficient to cover a multitude of errors and leave that margin so dear to the hearts of all who invest with a view to making more. If the vendors get their £242,000 they are to be congratulated at least equally with those who subscribe ; for although electric traction companies are wanted, it is possible to pay too much for a good thing.

It would be interesting to know how much of the above figure is represented by useful plant and machinery ; how much value is placed upon the patents, and the proportion allotted to goodwill. Goodwill is usually based on a certain number of years' purchase of the average value of yearly profits for a certain number of preceding years. A separate statement of the value of the installation of Barking Road would have been useful to other explorers in the field of electric traction.

It is pleasant to learn that the demand for electric launches has exceeded the supply. If these were let at paying rates, well and good ; but if run on the principle popularly supposed to have once been in operation on rival Thames steamboats of "carry you free and give you a supper"—although plenty of good-will would be exhibited, it would be hardly considered as a saleable asset. A launch profit and loss account, Cr. receipts, Dr. expenses and refreshments, would have been entertaining.

The purchase money includes a sum for the acquisition of a license from the Construction Corporation to use its traction patents, and a contract upon favourable terms for the supply of its accumulators. That Corporation paid a good round sum for the E.P.S. and other patents and goodwill, and is to be congratulated, too, on finding customers willing to make such an arrangement. How much is to be paid for this concession the deponents say not.

The prospectus quotes the North Metropolitan Tramway Company's report to the effect that the directors of that company are satisfied with the result of electric traction, for which they have paid 4½d. per car mile, which is less than the cost of traction by horses ; but what is satisfactory to the buyer is not always so to the seller. We sincerely trust that a profit accrued to the traction company from the rate charged to the tramway company ; but if so, it is a pity it was not stated. Businesses offered to the public as "going concerns" usually display a certificate from accountants of repute, setting forth the profits which have been made. To ask a large price for a business which has not paid should have about it "a nipping and an eager air," calculated to make the public put their hands in their pockets and keep them there. White elephants are luxuries which their possessors, however willing, are not always fortunate enough to dispose of to advantage.

The business of Messrs. Immisch & Co. is unique as regards its connection with mining, but here, again, no account is given of profits made ; and it looks as if we do not see them, because they are not there. The General Electric Power and Traction Company, Limited, has plenty of scope, and may some day pay good dividends on its very large capital ; and its cumulative 7 per cent. to the subscribing shareholders gives the latter a chance, but it means a net profit per annum at the rate of £7,000. It does not look as if the ordinary shares would be at a high premium just yet.

Electric Light at Sea.

AN interesting account reaches us of the narrow escape of the steamer *Beacon Light* on her voyage across the Atlantic last month when she collided with an iceberg of great magnitude. The ship was provided with a powerful search-light with reflectors, and during a heavy fog, about midnight, an immense iceberg was seen "towering above the vessel not 75 feet away. Orders were given to alter the helm and reverse the engines, but not altogether in time to clear the berg, which was struck by the starboard bow of the steamer. A large quantity of ice was dislodged and the ship was considerably damaged, but brought safely into port." It is not too much to say that their safety was due primarily to the electric light, which enabled them to see the iceberg earlier than would have been the case in ordinary circumstances.

Another Richmond in the Field.

HAS Dr. Carter Moffat, the inventor of that marvellous apparatus the "Ammoniaphone," found a false friend in the illustrious President of the British Association of Electricians? Such would seem to be the case, as the whilom senior and principal demonstrator, Surgeon's Hall, Royal College of Surgeons, Edinburgh, is now claiming that his feather-weight electric body belt is guaranteed to generate the same amount of electricity as other *more advertised* belts costing four times the amount. Moreover, the doctor's health-giving appliances—he is careful not to say electric belts—are said to be used by Her Majesty the Queen, the Prince and Princess of Wales, the Princess Louise, the Marquis of Lorne, Marquis of Salisbury, Mr. Gladstone, Lord Churchill, and many thousands of eminent men and women at home and abroad. It seems that the celebrated medical electrician of Oxford Street is about to enter upon another phase in his existence, viz., a competition with one who was once his benefactor; the struggle will be an interesting one, and we may now look for greater advances in science than the mere reduction of the unit of resistance to the milli-ampère.

Prospects of Copper.

IF one may take for granted the statements made by the chairman of the Namaqua Copper Company at the meeting of the company last week, the prospects in regard to the sale of copper were never brighter. Certainly the result of a year's work which was placed before the shareholders was gratifying to all concerned. The company's original prospectus stated that the cost of production would be at least £9 10s. per ton, a sum which over estimates the actual cost by 15s. In the sales the same satisfactory state of things has prevailed, and it is probable that this year a profit of £24 10s. will be made on each ton. The chairman has every reason to think that the value of the metal would be maintained, an opinion quite borne out by recent transactions. The demand for copper has been abnormally high during the past 12 months; in fact, the stocks in England and France, which stood at 124,447 tons on April 30th, 1889, are now under 90,230 tons. It is natural, on account of the recent great developments in electricity, that America should be responsible for a large consumption, and it is said that something like 30,000 tons have been used. It is further interesting to note that large consumers of copper in America are largely buying shares in the best copper companies, which is significant of the fact that there is not likely to be any sudden fall for a considerable period. There has been an increase in the demand for sulphate of copper, the sale of which has increased from 4,000 tons to 25,000. This is about to be largely used in the continental vineyards for the destruction of the phylloxera and mildew, and the producers of copper are fully alive to the probable result on the trade, as copper used for the last-mentioned purpose is practically lost for ever.

Electric Tramways in Birmingham.

THE relaying of the Bristol Road tramway in Birmingham again brings forward the question of the motive power. It is said that two electric cars will be run experimentally, but, as the *Birmingham Daily Post* says, past experience leads one to be somewhat incredulous as to the result. The work done on this line, from an electrical point of view, has been singularly unfortunate, for which various reasons have been given. We trust, for the sake of electrical traction, that any intended experiments will be placed in the hands of those capable of bringing the same to a successful issue.

The Eye of a Hawk.

A WRITER in the *Hawk* says:—"I am not over fond of accountant's 'certificates' or auditor's 'reports,' but I must confess that something of the sort is absolutely necessary in the case of such a scheme as the General Electric Power and Traction Company. The public is asked to subscribe £350,000 upon almost the bare statement that two electric lighting businesses are to be received in return for it. What proof have we that Messrs. Immisch and Company's business, or the business of the Electric Traction Company, are worth anything like the sum asked, or, for the matter of that, anything at all? Certainly the prospectus offers none. Both concerns have, I believe, been in existence five or six years, but it does not follow that they are paying properties, and the prospectus does not say that they are such. I should strongly advise investors to let this thing alone."

A Réunion.

ONCE again have the past and present pupils of Messrs. Crompton & Co., with a number of privileged guests, met together at the festive board over which Mr. Crompton so genially presides. On this occasion we had no Mr. Preece to prove that Job was a past pupil of the London and Chelmsford electric engineering firm, nor was the Mayor of Chelmsford present to give his version of the actual lighting of that town, which he only hinted at a year ago, but with these exceptions the meeting was very similar to that which we chronicled in our issue of June 7th, 1889. What was then said by Mr. Crompton regarding his pupils, and the integrity and impartiality of the electrical press, was repeated in the same sense, if not in the same words, and the replies were in a like strain. A new toast, "Our rivals in business," was very ably responded to by Mr. Garcke, who thought the time had arrived when electrical firms generally believed it to be better that one of their number should secure a contract at a profit, however small, than to seek to undercut him and take the work at a ruinous price. He paid a high compliment to the straightforward and open manner in which Messrs. Crompton invariably did business, and this was supplemented by a gentleman

who, perhaps to impress the pupils, said that those present doubtless knew him and that his name carried weight. He always advised anxious parents who wished to know what to do with their children to send their "Raw sons" to Chelmsford, and as he sometimes received about fifty applications in a day we think the hosts of the evening must have considered themselves fortunate in the possession of such a real friend. The toast of the "Visitors" was replied to by Mr. R. W. Wallace, and by a well-known engineer, who, although doubtless assenting to the dictum that speech is silvern, showed himself to be a true believer in silence being *Goolden*. Mr. Wallace, in what threatened to be a never-ending speech, gave the history of everybody connected with the doings of his entertainers, from the enterprising genius who first lighted Chelmsford with luminous paint, to the more studious and painstaking youngster who was always found at his post whenever he (the speaker) happened to visit a certain central station. However, with songs by Mr. Sennett and Mr. Gibson, and some instrumental selections, the evening was enjoyable enough and passed all too quickly, and it was nearly midnight when Mr. Albright, in a voice quivering with suppressed emotion and Apollinaris, replied in graceful terms to the toast of the "Firm," to which Mr. Crompton, in the most affable manner, allowed him to respond. We are sorry that we cannot devote more space to dilating upon the very admirable manner in which Messrs. Crompton and Co. set to work in order to secure the lasting esteem and friendship of their pupils, for nobody can have the slightest doubt but that feelings of the most amicable kind exist between the firm and its youthful staff, and this we feel assured will not readily be allowed to fade. In whatever part of the world the young engineer finds himself, and in whatever difficulty, he will always feel that he can, without any hesitation or false pride, apply for advice and assistance to his old teachers, with the certainty of knowing that his appeal will be answered. In too many instances teacher and pupil, when the latter is through his course, know one another no more; how much better then is it to strive, as do Messrs. Crompton, to secure a friendship which shall be one of a permanent nature.

C l brities at Home.

IT is not generally known that since Mr. W. H. Preece was a boy, five hours' sleep have been sufficient for his daily needs; and it is still more startling to learn that when he awakens in the early morning he sits up in bed, puts on a jacket, and sets to work with tablet and pencil. We always had an impression that the bulk of Mr. Preece's work was done under the shadow of St. Paul's, but this misapprehension, like several others under which we laboured, has been cleared up since we perused the *World* for May 28th. Those who wish to become acquainted with Mr. Preece, both as regards his personal qualifications and scientific attainments, should secure a copy of the journal named, for the writer has, we believe, given to the world for the first time the only authentic record of the doughty opponent of that *rising physicist* (this is how he is dubbed) Dr. Oliver Lodge. After all, what is fame?

Glow Lamps.

IT seems that the Langhans incandescent lamp, notices of which have appeared from time to time in the REVIEW, does not come within the claims of the Cheesbrough or Edison patents, or at all events the opinions of eminent counsel and experts are to this effect, if the nature of the operations and reactions which go on in Mr. Langhans's process can be established in fact. At the same time, if this lamp does not show any economy in electrical energy, it is unlikely that its exploitation will fill any great need, considering that the incandescent lamp monopoly has not much more than about two years in which to run itself out. Moreover, to bring forward another glow lamp during this period would assuredly lead to a law suit, even if the new filament is utterly devoid of carbon.

Atmospheric Resistance to Bodies in Motion.

NEARLY ten years ago the late Robert Sabine showed in our columns the absurdity of certain schemes then being mooted for running electrically propelled trains at speeds reaching 200 miles an hour. He proved that to move a vehicle, only offering to the air resistance a square foot of surface, would necessitate a much more powerful electro-motor than had in those days been constructed, leaving alone other considerations, such as jumping the rails, &c. Now we notice that Mr. O. T. Crosby has been at work upon this important subject, and in the last issue of the *Electrical World* there is published the results of his experiments and these, or an abstract, we hope to produce in a future issue. It cannot be too forcibly brought home to the minds of these enthusiasts who think that all kinds of impossibilities are to be easily set aside by the aid of electricity, that it requires an enormous horse-power to move an ordinary passenger train at 50 miles an hour whether it is derived from steam or electrical energy. Mr. Crosby quotes an instance of a N.Y. central passenger train, consisting of engine and tender, three day and six sleeping coaches, which at 51½ miles an hour developed 766 H.P. Yet this is a mere trifle in the eyes of those who persistently adhere to the always coming 200 miles an hour.

Electrical Theories.

IN *Knowledge* Mr. R. Camper Day, B.A., Oxon., commences a series of papers on "A Simple Explanation of Clerk Maxwell's Theory of Electricity." He prefaces his work with a reference to Dr. Lodge's book, *Modern Views of Electricity*, in which the author endeavours to show how the various effects of electricity can be illustrated by means of mechanical models. Mr. Day shows how difficult it is for the student to reconcile the working models of static and current electricity, for as the electricities are undoubtedly one and the same thing, he naturally endeavours to combine the two models in his mind. Mr. Day does not propose to follow Clerk Maxwell's abstruse arguments which depend almost entirely upon problems in higher mathematics, but merely to give an elementary and pictorial outline of the mechanism which he suggests.

Physiological Effects of the Current

MESSRS. NEWMAN LAWRENCE AND HARRIES will doubtless peruse with interest the paper which we publish by Dr. Tatum. We sincerely trust that these experimenters may be encouraged to persevere in their researches, and that the Institution of Electrical Engineers will invite them to bring forward the results during the next session.

ANDREWS'S CONCENTRIC WIRING AND FIRE RISKS.

NOTWITHSTANDING the application of excellent workmanship and good material in connection with electric light wiring in buildings we cannot but admit that the system, as generally in use, is greatly wanting in substantiality and safety from fire risk and extinction of the light. It was with a view to improving this state of affairs that Mr. J. D. F. Andrews, some six or seven years ago, commenced to introduce concentric wiring into interiors, and has ever since continued its application whenever possible, gradually developing the innumerable accessories to the system. In the present article we shall do no more than review the principles relating to the subject, leaving for the near future a detailed description of the joints, switches, fuses, and other appurtenances of the system.

In order to treat the subject effectually it will be necessary to introduce some of the remarks made by Mr. Andrews in a paper he read last year at the Philosophical Society of Glasgow.

The causes of fires in electric wires may be classed under three headings—the short-circuit, the partial short-circuit, and the opening circuit. An excellent provision against the dangers of the short-circuit is found in the fuse or cut-out, and it is only in case this appliance is badly constructed, or has been tampered with, and consequently must fail to act, that this fault need be considered. In the case of a partial short-circuit the increase of the current is generally insufficient to melt the fuse, and in such an instance this protector (the fuse) has been found to be a source of danger, for, although it may not melt, it may become so hot as to ignite inflammable substances that come against it. This may take place even if the fuse is constructed on the most approved lines, because of the long duration of partial short-circuits and consequent accumulation of heat in the fuse. The partial short-circuits themselves are often very curious and interesting developments. The most common form is a general leakage from one wire to the other through damp woodcasing over a long length. If this continues the casing is liable to become charred at the best conducting place and begin to glow and flame. Many curious instances of this kind have been known, and we will describe one peculiar instance that occurred on an Atlantic liner. The casing was saturated with moisture for a length of about 6 yards, but the course the electricity preferred was a diagonal line about 18 inches from one wire to the other, along which the wood was deeply charred. This suggests the theory that wood conducts better with the grain than against it. Under the heading of opening circuits come all those faults where the conductor carrying the current gets ruptured, and an arc or bad conducting bridge is established across the break. These are generally the result of moisture on the wires, in a similar way as partial short-circuits are. The wire at the attacked place gradually thins until it is incapable of carrying the current without heating. The casing thereby becomes charred, and by the time the wire is corroded through there is a bad conducting bridge prepared through the charred wood, by which the current passes, setting the wood aglow and gradually increasing the breach in the wire. The length of charred wood through which the current will pass in this way has been known to reach 10 inches to 12 inches.

Electrolysis also plays a part in producing opening circuits. The writer was shown a length of wire taken from a ship installation, with copper deposited near one end that had obviously been removed electrolytically from a point near the other end, where it was reduced in thickness. This wire had been taken from a wood casing in which salt water had continually lodged in a length of about 8 feet. Opening circuits, in the case of small wires, are also produced by the wood casing drying and contracting and breaking the conductor, generally at the joints. The twisting of ships and vibration and settling of buildings have been known to cause the same fault. The opening circuit has probably caused more fires than any other fault, and it is the most difficult of all faults to provide against.

It has been necessary to consider the nature of the faults in electric wires to the above extent, in order clearly to understand the real advantages of the system of concentric wiring as introduced by Mr. Andrews. It must be obvious that to avoid the serious fire-producing faults in electric light wires, the moisture-harbouring wood casing must be abandoned, the tensile strength of the conductors must be increased, and a means of automatically indicating or detecting all faults must be provided.

Mr. Andrews claims (and, we believe, with perfect justice), to have fulfilled all these functions completely by his system of concentric wiring, the simple principles of which we will now lay before our readers, that they may form their own judgment.

The usual construction of the wire, as hitherto used by Mr. Andrews in most of his installations, consists of a core of vulcanised India-rubber insulated copper wire, surrounded by an armouring of iron wires seven times the cross-sectional area of the central conductor. In cases where the wires are not exposed to view, or where they are likely to be exposed to moisture, the outside conductor is also enveloped by an insulating material sufficient to resist any effects of water. The armouring forms the return conductor, and is of great strength and rigidity, and capable of resisting all the strain that might tend to break or crush the wire.

The principle upon which the claim of safety against fire risk is based is the fact of the two conductors being so close together that there could not be an arc or any excessive heat in one without its influencing the other, and the consequent establishment of a dead short-circuit. It would not be sufficient, in order to gain this purpose, simply to bring the two ordinary conductors side by side close together, because, in the first place, the conductors could not be brought sufficiently near to each other to cause a completely-fused junction, should an arc take place in one of them; and, in the second, the fire would be exterior to the conductors, and could ignite anything in the neighbourhood. Nor would it be sufficient to make the surrounding conductor only the same weight as the central one, because in such a case of an insufficiency of metal, the defect would exist with two wires side by side. To increase the copper in the outer conductor to sufficient dimensions render the concentric cable too costly, hence the ordinary iron armouring is found in every respect most satisfactory. The double copper concentric wire with lead armouring also, does not present the same advantages with regard to safety as the iron armouring. The lead is only a slight protection against exterior damage, and it might be a serious source of danger if an arc struck across between the copper conductors, and caused the lead to melt and flow.

With concentric wiring, opening circuits and partial short-circuits practically disappear entirely with all their serious damaging influences, and leave behind only the short-circuit, which is easily met by the fuse. The fuse therefore plays the part of complete protector of the system, as well as indicator of faults.

The great difficulty to overcome in perfecting the system has been in making perfect electrical and mechanical continuity in the joints, especially of the surrounding conductor or armouring. Mr. Andrews, under his recent patents, has succeeded most effectually and in an exceedingly simple way in surmounting this difficulty, and we shall describe them in our next article on this subject. The concentric principle is carried into all the details of the fittings. The cases of the switches and fuses form the return conductor, and likewise the brass of the fittings. There is consequently no portion of the system where the opposite conductors are sufficiently far apart to admit of the formation of an opening circuit or a partial short-circuit. Every detail of the system is constructed watertight, and the same high class insulation that is employed on the core is also used on the wires passing through the fittings. And this, we

may add, is one of the greatest safeguards, as hitherto with the double wiring the insulation has been greatly reduced in the fittings, in consequence of the confined space not admitting the heavier quality, with the result that fires have often originated in the fittings.

It would be ambiguous to say that concentric wiring for interiors is faultless. There is at least one objection to it, but this is not relating to the system in itself so much as to the telephonic system. An earth connection with concentric wiring is almost unavoidable, and conductors in the neighbourhood are liable to assist in the return conduction of the current. If alternating currents are used there is the well-known influence on telephones; with continuous currents the effect is exceedingly slight, if at all. It is, however, only under specially unfavourable circumstances that this influence can take place; and up to the present time, Mr. Andrews informs us, there has been no trouble with it. For cases where it is important to consider this point, Mr. Andrews takes the two conductors, equally well insulated from earth, up to the lamp; but as this destroys the simplicity and substantial character of the various devices, it would be better, if such a case arises, to put the telephone upon a metallic circuit, which would be an advantage for other reasons. Beyond this one objection, which is not a serious one, we have nothing derogatory to say regarding the system, which, on the other hand, has many conspicuous points of advantage, such as great simplicity and practicability, besides the safety from fire risk above referred to.

Mr. Andrews has pioneered the introduction of concentric wiring into interiors and ships, having carried out over a hundred installations with it, and he has obtained several patents on joints and various appurtenances, of which we are promised details for early publication.

LIGHTNING CONDUCTORS.*

By S. ALFRED VARLEY.

SECOND SERIES.

THE deflagrating powerlessness of lightning relatively to the actual amount of energy which must be stored up in a thunder cloud has already been referred to in an earlier contribution. Lightning discharges may be compared not unfairly to spitting discharges such as take place, where two Leyden jars, standing on a wooden slab, are charged oppositely, until discharge occurs through the wood on which they are standing. It is fortunate for the inhabitants of this world that the clouds and the surface of the earth are such imperfect conductors, seeing that a Leyden arrangement having metallic sufaces of only 73 square feet each, is capable of deflagrating 30 feet of fine iron wire.

It would be easy to determine approximately the amount of energy which must be accumulated in a thunder cloud having, say, a square mile of surface charged to a potential capable of breaking down, say, one mile of air space. All that would be necessary would be to construct a Leyden arrangement of two copper plates, separated by an air space, and having, say, 100 square feet of surface in each plate. If such a Leyden arrangement were charged to the highest potential it was capable of retaining, with a progressively varying amount of air space between the plates, the law governing the electrical deflagration of wires could be determined by direct experiment and the amount of energy accumulated in a thunder cloud of given surface and given distance at the time of a discharge could be determined.

When a Leyden jar is discharged, practically the whole of the accumulated energy becomes dissipated by a single spark; but in the case of thunder clouds, the energy becomes dissipated through the medium of a great number of discharges, and further, the greater percentage of the energy dissipated by each discharge is spent in overcoming resistance encountered in the clouds themselves, the surface of the earth, and in breaking down and heating the air molecules.

When a wire is deflagrated by a Leyden battery, as the lateral induction is but small, the breaking down of the molecules throughout the whole length of the wire may be regarded as occurring simultaneously; but as there is actually a certain amount of lateral induction, a + and — wave commencing at either end of the wire, and meeting midway, occurs. Wheatstone's revolving mirror experiments demonstrate this to be so.

Gaseous atmospheres which may be fairly regarded as conductors having a very high specific resistance, may be imitated somewhat crudely; but at the same time they may be represented not unfairly by means of carbon powder in a very fine state of division.

Insert the two poles of a 50-volt battery into loosely arranged, finely divided household blacklead, and it will be observed that no current passes; but if the poles of a 300-volt battery be inserted, the blacklead particles become arranged into actual contact with one another by electrical attraction and form a conducting bridge, the current which then passes develops heat in the particles which form the path of discharge, reducing their resistance, and, as a consequence, the tendency is to confine the path to a row of particles of limited number. Precisely the same thing occurs when lightning discharges through the atmosphere, a row of air molecules of comparatively limited section become broken down and heated, and the discharge is confined to an air path of comparatively small section, the conductive resistance of which has been greatly reduced by the heat developed.

Now heat a considerable quantity of carbon powder in a crucible to a full red heat, and insert the poles of, say, a 10-volt battery into the red hot powder, the resistance opposed, according to the writer's experiments, will be found not to exceed 6 ohms, and, further, it will be found that the resistance is practically the same whether the poles of the battery be separated a few inches apart, or, say, only $\frac{1}{20}$th of an inch, the reason being that the current passes through a larger section of particles when the battery poles are separated some distance from one another, and in this experiment we have an illustration of the manner the earth comports itself in telegraphy, opposing practically no resistance whatever when it forms part of the electrical circuit.

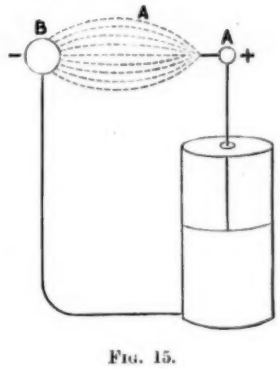


FIG. 15.

Let A, fig. 15, represent an air space dividing the + and — conductors of a Leyden jar. If the jar be charged slowly, discharge will occur in the form of a purple flame or brush; this purple flame indicates the way in which the air molecules are brought under the influence of induction, and it also enables the mechanism of statical discharges through the air to be studied. In the immediate neighbourhood of the pointed + conductor a smaller number of air molecules come under the influence of induction than is the case midway between the oppositely-charged conductors, and the stress to which these molecules are subjected is

* For end of first series see REVIEW for April 11th, 1890.

greater inversely as their number is less, and the consequence is they break down sooner than the layers of molecules situated midway do, where the section is larger. What really occurs is a series of short discharges from molecule to molecule, commencing in the immediate neighbourhood of the oppositely-charged conductors, and progressing through layers of molecules of increasing number until discharge becomes completed midway between the + and — conductors. It will be seen that as the section of the path of discharge is greater in the central portion than it is in the neighbourhood of the + conductor, the discharges through the layers of molecules are not simultaneous throughout the whole of the air space, but that they *must* necessarily occur *more slowly* as the section of the path becomes greater.

Now if the rate at which the Leyden jar is being charged is increased so that the potential of the statical charge becomes raised faster than brush discharge can lower it, the jar will become discharged by a single spark leaping the whole length of the air space ; and what it is desired to direct attention more especially to is that such spark passes *through the centre* of the brush path of discharge, the purple flame disappearing at the same moment as a discharge occurs.

A brush discharge may be considered as being an approach to a continuous current. A continuous current differs from a brush discharge in the fact that the electricity passes from molecule to molecule simultaneously throughout the whole length of the conducting path, whereas when discharge occurs in the form of a brush the passage of electricity from molecule to molecule is not simultaneous throughout the whole length of the path ; in the immediate neighbourhood of the + conductor (fig. 15), where the sectional area is small and the air molecules comparatively few in number, the discharge from molecule to molecule is so rapid that it has the appearance of a continuous stream, but as the section and the number of air molecules composing the path become increased, a longer interval of time elapses between each successive discharge, for the air molecules must necessarily be charged to the breaking down potential for electricity to be transmitted, and proportionately as the number of molecules composing the path becomes greater so more time is required to raise them to the necessary potential, and moreover, as the time elapsing between the discharges is longer, they are not so highly heated as the molecules immediately contiguous to the + conductor, and their specific resistance is consequently greater.

The purple flame, such as that indicated in Fig. 15, is certainly a conductive path through which the electrical discharge is occurring, and we see that when the potential of the statical charge is raised more rapidly

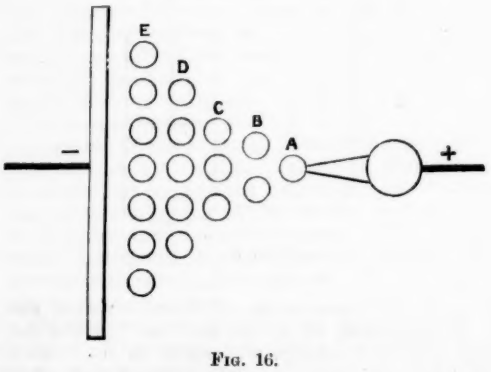


FIG. 16.

than a brush discharge can lower it, and spark discharge as a consequence occurs, the spark *does not pass over the outer skin* of the conducting path, but through the centre, and the simple fact that it does do so, should, it is considered, make mathematical physicists hesitate as to the soundness of their present views in reference to the passage of lightning through the medium of lightning rods, in *the absence* of direct experiments, which positively demonstrate that transient currents are confined to the outer skins of conductors.

Fig. 16 is intended to indicate the mechanism of a brush discharge from a + charged conducting point to a flat — surface. A represents the group of air molecules immediately contiguous to the + conductor, and A, B, C, D, E represent the layers of molecules of increasing section through which discharge proceeds. Now, it is evident that as the number of air molecules in the group, A, is only one-seventh of that composing the layer, E, discharge must occur seven times as rapidly through A as through the molecules composing the layer, E, and therefore it follows that discharge cannot occur simultaneously through the successive layers of air molecules which compose a brush path of discharge.

When a Leyden jar is discharged through the medium of brush discharge, such discharge is effected of course very much more slowly than when it is brought about by a spark discharge, but nevertheless there is no hard and fast line separating these two forms of discharge. We know from Wheatstone's experiments that a spark discharge is progressive, commencing at either end of the path and meeting midway, very similarly to what is observed in the case of an electrical brush, and that being so, it seems more than probable that if a spark discharge could be photographed, the sensitive plate being exposed for a shorter interval of time than that occupied by the act of discharge, that such discharge would be seen to be broken up into a number of short sparks, and therefore the revolving mirror experiments of Prof. Oliver Lodge, and also the experiments recently performed by that very able experimenter, Mr. C. V. Boys, cannot be fairly regarded as demonstrating that Leyden jar discharges are oscillatory.

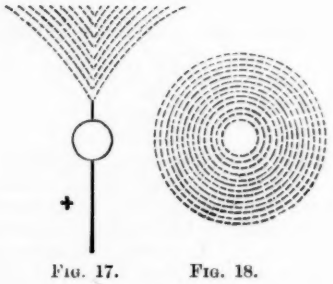


FIG. 17. FIG. 18.

Fig. 17 is intended to represent the mechanism of a brush discharge proceeding from a pointed + conductor into the atmosphere, the electrified air molecules increasing in number as the distance from the conducting point becomes increased, and also repelling one another because electrified similarly. Fig. 18 represents a cross section of an electrical brush. It will be seen that the stress to which the inner molecules are subjected must equal and balance the stress divided over the larger circles of charged molecules which surround them, and that therefore the potential of the central molecules will be a little higher than that of the outer ones, and here the writer ventures to think is the explanation of the fact observed both by Reiss and also by Thomson—viz., that the sparking distance between oppositely charged parallel plates separated by an air space was a little greater than the increase of potential, or, as the writer would say, the general potential. In that portion of the article where the experiments of Reiss and Thomson with flat parallel plates were referred to, the writer ventured also to express the opinion that when discharge occurred between the oppositely charged circular plates the spark occurred in the neighbourhood of the centre of the plates, and for the reason that the potential, it seems to him, must be somewhat higher in the centre than in the neighbourhood of the outer periphery. The observations of the late Andrew Crosse also go to show that the centre of

a thunder cloud is at a higher potential than the outer edge of the cloud.

The newer development of electrical theory which has led mathematicians to the conclusion that the central portion of a conductor is stolidly inert to lightning conductors, seems to the writer to overlook altogether the part induction plays in electrical phenomena, and he is of opinion that nearly all the necessary data for arriving at a correct conclusion are to be obtained by studying the phenomena observed in connection with practical submarine telegraphy.

In a working submarine circuit we have an example of the transmission of energy by means of electrical alternations, not so unlike an alternating electric light system, the chief difference between them being that certain phenomena common to submarine circuits and to alternating electric light systems, are exalted in the one to a very much higher degree than they are in the other.

A submarine circuit shows the relationship which exists between dynamic and statical electrical phenomena, for we there see electricity primarily dynamic transformed into static electricity, and from the statical condition we see it resolve itself back again to the dynamic state; and further, as the writer himself pointed out as far back as 1858, we also observe the insulated copper conducting wire performing the two-fold function of insulator and conductor. Its conductive capability enabling energy to be transmitted across the ocean in which it is submerged, its insulating properties permitting the accumulation of statical charge, and in this two-fold action of the copper conductor practical evidence is incidentally afforded that no line of demarcation separates conduction and insulation, that, in fact, conductive resistance and insulation are convertible terms. As a consequence arising out of the insulating capabilities of conductors there may be, in a long submarine circuit, two or three dynamic waves travelling in opposite directions to one another at one and the same time, and along with such waves also statical accumulations of electricity developed by the inductive action of the dynamic electricity through the insulating sheathing.

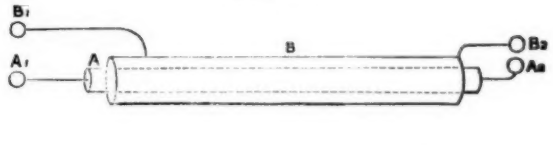
The germs of all that submarine telegraphy has revealed were indicated, in some cases more than indicated, in Faraday's laboratory researches, but, nevertheless, what Faraday had demonstrated was entirely overlooked, and was not, in any true sense of the term, grasped as knowledge by our mathematical physicists in 1858; and, in the opinion of the writer, the so-called advance in electrical theory is evidence that some of our physicists do not seem to have grasped as working knowledge, what Faraday was familiar with, and taught.

One of the lessons which the observation of the phenomena of submarine telegraphy brings clearly home is that dynamic electricity acts inductively on neighbouring matter—the fact that statical accumulations of electricity occur which correspond to, and are determined by the direction the electrical waves are moving through a submarine circuit is evidence of this.

Mathematical physicists now assure us *most positively* that the central portion of a conductor is practically idle when rapid electrical alternations are being transmitted, and Sir William Thomson has brought his special abilities to bear on the point in question, and he has calculated the actual depth that electrical alternations under specified conditions penetrate into the outer skins of conductors.

The teachings of Faraday, and practical research in connection with submarine telegraphy, lead the writer to the conclusion that electrical alternations passing, as assumed by mathematicians, through the outer skin of a conductor would act inductively on the interior portion and not allow it to be idle. Observation and study of physical phenomena as one great whole (as far as he has been able to do so) also lead the writer to the conclusion that the central part of a conductor, far from being stolidly inert to transient currents, is as a matter of fact at a slightly higher potential than that of the outer skin, and for a similar reason that the potential of the central portion of thunder clouds, as observed by Crosse, is higher than that of their outer edges. The views here contended for also receive support from what Sir William Thomson himself, as well as Reiss, observed and have recorded in connection with their experiments with oppositely charged metal plates separated by an air space. Common sense reasoning would also suggest that electrical currents, whether they be steady or transient, should follow similar laws, and as what is termed a current, be it electrical or otherwise, is simply a transmission of energy through matter, what is noticed when energy is being transmitted by a flowing river, the water flowing down the centre faster than at the sides, if considered in connection with that harmony which seems to run through, and to link together all physical phenomena, would suggest that it is more than probable that the central portion of an electric conductor is at the very least as effective, so far as the transmission of energy is concerned, as the exterior parts.

FIG. 19.



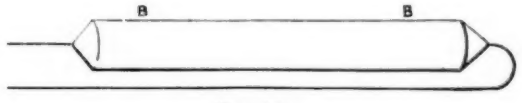


FIG. 20.

Construct a Leyden arrangement of two long metal tubes, separated either by an air space or a glass tube, fig. 19, and statically charge it by an influence machine. Now, assuming, as represented in the sketch, that the inner tube which forms the inner coating of the Leyden arrangement has only one half the surface of the outer coating, as the + and − charges must necessarily balance one another, the potential of the charge on the inner coating must have twice the potential of that of the outer coating, and as the energy associated with statical charges is as the square of the potential of the charge, it should follow that twice the energy is accumulated on the inner coating, and, that being so, it follows that if this tubular Leyden arrangement be charged until discharge occurs between the metal balls, A_2 and B_2, then the energy accumulated on the inner coating should be capable of travelling at twice the speed of that on the outer surface.

Let B, fig. 20, represent a long solid copper cylinder of large diameter, and connect the two ends by means of the conductors, A, A_1, to the two poles of an alternating current dynamo, if the alternations passed through the outer skin only, it is thought a + alternation would act inductively on the interior, driving out a + current, and the reverse action would occur at the time a − alternation was passing.

Let B, fig. 21, represent a Leyden arrangement, consisting of two long metal tubes separated by a dielectric, connect the conductor, B_2, to the outside of a charged Leyden jar, and approach the ball conductor connected to the inner coating of the jar near enough to A_1 for discharge to occur; at the same time as a spark occurs at A_1 between the inner coatings of the Leyden jar and the inner coating of the tubular Leyden arrangement, a spark will occur across the air space, B_1, between the outer coatings of the tubular Leyden arrangement and that of the Leyden jar, and the tubular Leyden arrangement will now have received a statical charge.

Let fig. 22 represent a Leyden arrangement similar to fig. 21, but insulate the outer coating, B, and let the interior tube, A, form the path of discharge of a Leyden battery of large surface. At the time discharge occurs through A, the writer ventures to think a spark will be

observed between the balls, B_1 and B_2, indicating that a secondary current has been developed in the outer tube, B, as a consequence of the magnetic inertia and self-induction of the inner tube, A. Now place a solid metal cylinder inside the interior of the inner tube, A, so as to increase its mass, and discharge the Leyden battery through it as before ; if the views held by the

FIG. 21.

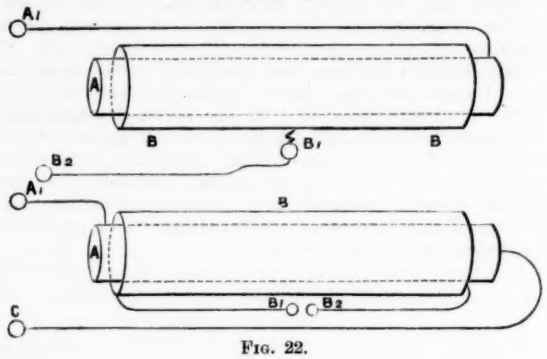


FIG. 22.

writer be correct, the secondary spark developed between the balls, B_1 and B_2, will now be a heavier one, owing to the greater inertia opposed by the more massive conductor, and should the experiment demonstrate that this is so, there would then be conclusive proof that Leyden jar discharges pass through the mass, and that the interior portion of a lightning conductor is not stolidly inert at the time a lightning discharge takes place through it.

(*To be continued.*)

ON THE EXCITEMENT OF ELECTRICITY AND HEAT IN ELECTROLYTES.

By MAX PLANCK (*Annalen der Physik und Chemie*).

(*Continued from page* 601.)

Section 7.—Change of Temperature by Diffusion.

WITH regard to the density 1, the heat capacity 1, and the thermic conductivity, k, of the water, the differences of temperature which occur on the diffusion of two solutions p_1 and p_2, initially of equal concentration, may be fully calculated according to the theory which has been developed. In any volume element the temperature θ varies, firstly, on account of the heat brought by the surface and, secondly, on account of the heat above calculated produced in the element. The latter is deduced from the equation (14) if we put $J = 0$ and $x' = x + dx$, and it has to be divided by the mechanical heat element $A = 424{\cdot}36 \times 10^5$ for reduction to gramme-calories. The change of the temperature in time is then :

$$\frac{\delta\theta}{dt} = k\frac{\delta^2\theta}{\delta x^2} + \frac{R}{A} \times \frac{4uv}{u+v} \times \frac{\delta^2 p}{\delta x^2}$$

or, with reference to the values of $\delta^2 p/\delta x^2$ and a^2 from (17)

$$\frac{\delta\theta}{\delta t} = k\frac{\delta^2\theta}{\delta x^2} + \frac{p_1 - p_2}{2aA} \times \frac{x}{\sqrt{\pi}\, t^{\frac{3}{2}}} \times e^{-\frac{x^2}{4a^2 t}}$$

Further, θ for $t = 0$ and x a constant $= \theta_0$.

The complete solution of these conditions is given by :

$$\theta - \theta_0 = \frac{2a^2(p_1 - p_2)}{(k - a^2) \times A\sqrt{\pi}} \times \int_{\frac{x}{2\sqrt{kt}}}^{\frac{x}{2a\sqrt{t}}} e^{-w^2} dw \quad (18)$$

as it may be easily verified. Thus the temperature is obtained as a function of place and time. According to (15) we may also write :

$$\theta - \theta_0 = \frac{2a^2}{(k - a^2)A}\left[p\left(\frac{ax}{\sqrt{k}}\right) - p(x) \right]$$

in which $p(x)$ signifies the osmotic pressure at the point x. The change of temperature (positive in the more dilute solution) at a point, x, is therefore proportional to the difference of concentration which exists between this point and a point of the same solution nearer to the original plane of separation in the proportion $a/\sqrt{k}$. For the solution of H Cl above mentioned the

$$a/\sqrt{k} = 0{\cdot}133.$$

At the original plane of separation of the solutions $x = 0$, the temperature remains constant at all times, $= \theta_0$; on the other hand, there exists for the given time, t, on the one side, a special maximum temperature, and on the other a minimum temperature, and — as it is found by the differentiation of θ according to x at the distances :

$$x = \pm\sqrt{t \times \frac{2ka^2}{k - a^2} \times \log\frac{k}{a^2}}$$

Thus the maximum and the minimum deviate from each other symmetrically and continually more slowly to infinity.

For the diffusion of HCl, *e.g.*, after the expiry of the first hour $t = 60^2$, the position of the maximum and miniature temperature is given by :

$$x = \pm\, 0{\cdot}306$$

so that at this time the maximum and the minimum are at the distance from each other of 0·612 centimetres.

The amount of the maximum and minimum temperature is quite independent of the time, as it immediately appears if we calculate the accompanying temperature θ for the value of x from (18) given in the last formula. We find then :

$$\theta - \theta_0 = \pm\frac{2a^2(p_1 - p_2)}{(k - a^2)A\sqrt{\pi}} \times \sqrt{\frac{k}{2(k - a^2)}\log\frac{k}{a^2}} \int e^{-w^2} dw \Big/ \sqrt{\frac{a^2}{2(k - a^2)}\log\frac{k}{a^2}}$$

The value of the integral is constant, independent of the time and the concentrations. For HCl the lower limit will be 0·191, the upper 1·434 and the integral receives the value 0·66. If we again take, as an instance, the diffusion of a normal solution of hydrochloric acid into pure water then $p_1 = 0{\cdot}001$ R, $p_2 = 0$, whereby the maximum and minimum temperature are determined as :

$$\theta - \theta_0 = \pm\, 0{\cdot}0077.$$

Therefore the greatest difference of temperature in the process of diffusion in question, which may occur between a heated point on the one side and a refrigerated point on the other, is 0·015°. Its demonstration in the thermo-electric way may be not impossible, at least qualitatively. In a quantitative investigation the degree of dissociation would have to be considered.

(*To be concluded.*)

Leprosy Cured by Electro-homeopathy.—The Calcutta correspondent of the *Daily News* telegraphs : Father Müller, of the Jesuit's College at Mangalore, claims to have cured several cases of leprosy by Count Mattei's system of electro-homeopathy. He gives a description of the statement, and states the cost to be only 10 rupees for each cure. A gentleman at Calcutta claims to have effected cures by similar treatment.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 538.)

VIII.—ARMATURE REACTIONS (*continued*).

ASSUMING, with Mr. Swinburne, that the brushes are approximately under the pole corners, if θ represents the angle embraced by each pole piece in degrees, the magnetising force producing a cross field is $\frac{2\,\theta\,A_2}{360}$. We have then, stated generally, the equation

$$\frac{2\,\theta\,A_2}{360} = 2\,l \times \cdot 8\,I$$

which gives for an induction equal to nought under the brushes

$$A_2 = \frac{288\,l\,I}{\theta}$$

In practice the safety margin brings the ampère turns down to about half of this value, and

$$A_2 = \frac{144\,l\,I}{\theta} \qquad (1)$$

expresses fairly well the degree to which armatures are usually loaded. If we call r the radial depth of the armature core and w the angular width of each pole piece in centimetres, we may write for I, the induction in the gap, its value $= \frac{2\,r\,I_2}{w}$ where I_2 is the induction in the core per square centimetre. The equation then becomes

$$A_2 = \frac{288\,I_2\,r\,l}{\theta\,w}. \qquad (2)$$

In cylinder machines where I_2 is between 17,000 and 18,000, and θ 120°, the permissible ampère turns on the armature are under these circumstances

$$A_2 = \frac{42{,}000\,r\,l}{w}. \qquad (3)$$

The latter formula agrees closely with that given by Mr. Esson who, in his paper read before the Institution of Electrical Engineers recently, gave several examples of cylinder machines and the coefficients for their armature loads. In the paper, the product of the exterior conductors and half the current is called the ampère turns, and the coefficient, 42,000, would in that case be doubled. The actual value given was 85,000. This latter formula may be very well used to afford a rough indication of the load which may be carried by Gramme armatures, since variations within the limits of practice in the angle embraced by the pole pieces, make consequent upon the large margin it is usual to allow, but little difference in the tendency to sparking.

The above observations have an equally important bearing on the design of multipolar machines, since the permissible load for these is determined by precisely similar considerations. The ampère turns on the armature of a two-pole machine are, as already stated, the product of half the exterior conductors and half the total current; in the case of a four-pole machine they are the product of one-fourth the conductors and one-fourth the current, while in six-pole machines they are one-sixth the conductors into one-sixth of the current. The ampère turns are in fact $= \frac{W\,C}{p^2}$ where C is the total current flowing, W the exterior conductors, and p the number of poles, the armature sections being connected up so that there are as many parallels as there are poles. The induction in the air gap of multipolar machines is frequently greater than in that of two-pole machines as the width of the pole-piece is generally less compared with the distance between the tips.

Let θ represent, as in the two-pole machine, the angle embraced by the pole piece in degrees in machines of the multipolar type. On the assumption that the brushes are close to the pole tips the ampère turns producing the cross field will be $\frac{p\,\theta\,A_2}{360}$, and

$$\frac{p\,\theta\,A_2}{360} = 2\,l \times \cdot 8\,I.$$

whence

$$A_2 = \frac{576\,l\,I}{p\,\theta}$$

for an induction equal to nought under the brush, or allowing the same margin as before for practical working

$$A_2 = \frac{288\,l\,I}{p\,\theta} \qquad (4)$$

As mentioned above $A_2 = \frac{W\,C}{p^2}$, and substituting this value for A_2, we have

$$W\,C = \frac{288\,l\,I\,p}{\theta}, \qquad (5)$$

which affirms that the product of the total current and external conductors is directly proportional to the number of poles, and inversely as the angle embraced by the pole pieces.

Suppose we have two machines, one of which has two poles and the other four, the proportion of periphery embraced by all the poles added being in both cases the same. In the four-pole machine the angular width of the pole piece in degrees θ, will be half what it is in the other, and the poles, p, being doubled, W C will be four times as great, provided the induction in the gap and the length of the gap are similar. We may therefore have four times the conductors if the same total current is to be carried, each conductor carrying, of course, one-fourth of the current or one-half of that carried by each in the case of the two-pole machine. As a general rule, the angle embraced by the pole pieces may be assumed as inversely proportional to the number of poles, in which case $p\,\theta$ is constant, and, as may be seen from (4), the ampère turns have the same value whatever the number of poles. From (5) we see that on this assumption W C is proportional to p^2.

The term ampère turns, as applied to the armature load, is not free from some inconvenience in its application, and it becomes preferable very often to consider the *volume* of current flowing along the armature, this being the product of the conductors counted all round the exterior and the current flowing in each. It is as if we substituted for the winding a thin cylinder of copper enveloping the armature in which there flows a current in the direction of the spindle equal to the sum of all the currents in the exterior conductors. In the case of a two-pole dynamo, two lines drawn along this cylinder in line with the brushes, will divide it into two semi-circular shells in which the current flows in opposite directions. In a four-pole machine it will be divided into quadrants in which the current flows in opposite directions in adjacent ones. In a six-pole it will be divided into six parts, and so on, the number of segments being always equal to the number of poles. Now it will be observed that the ampère turns, A_2, are in all cases equal to the volume of current in each of these segments. In the two-pole machine the volume in the semi-circle is $\frac{W\,C}{4}$, which is equal to the ampère turns on the armature. In the four-pole machine the volume in a quadrant is $\frac{W\,C}{16}$, which is again the ampère turns on the armature, and so on. The ampère turns being $\frac{W\,C}{p^2}$ the volume is obviously these multiplied by

the number of segments or poles, and is equal to $\frac{W\ C}{p}$. Call it V. Substituting for A_2 its value in (4) or for W C its value in (5) we get for the volume which may be carried

$$V = \frac{288\ l\ I}{\theta} \qquad (6)$$

Comparing this with (1) it will be seen to be identical as in a two-pole machine, V is twice A_2. This expression, however, is applicable to any machine independently of the number of poles it may have, it is more convenient to apply than any of the others, and shows the load which may be carried at a single glance. When it is remembered that in multipolar machines the windings are not always connected as here described, its convenience will be still more apparent as it is quite independent of the manner of joining up.

The equation (6) shows that by putting four poles on a given size of armature instead of two, the volume of current may be doubled, even if the proportion of the circumference embraced by all the poles added remains the same. For instance if we substitute four poles each embracing 60°, for two poles, each embracing 120°, the polar angle being halved the volume can be doubled without overstepping the sparking limit. Whether by increasing the load we shall get beyond the limit of temperature rise is a question which will have to be considered later on. There are obviously several conditions, other than sparking, which determine the design, although it is to the consideration of the latter point only that we have confined ourselves in this section. It is but right to say that experimenters are by no means agreed upon the exact form of expression which should govern the loading of armatures. Mr. Ravenshaw, for instance, has a rule for the load which presents no resemblance to those here given, and which makes it simply proportional to the area of the armature core. Mr. Swinburne, in his recent paper on "The Theory of Armature Reactions," attempted to fix the limiting load on the assumption that the brushes were under the polar tips, or more correctly, that they were just on the border of the fringe of field which bounds the polar expansions. The assumption seems open to doubt, as the position of the brushes between the no-lead line and the pole tips depends upon the load carried, and it is possible that a fringe of field sufficient to reverse the current in the section extends beyond the confines usually assigned to the fringe in working out the magnetising force required for the air gap induction. Mr. Swinburne places his brushes in the position above-mentioned, and says in effect "the brushes being here the ampère turns on the armature must not exceed a certain limit, or there will be no forward field to reverse the current in the section." But it is found in practice, as might have been expected, that armatures are not loaded with more than about one-half of the ampère turns fixed by the theoretical limit. The close agreement between the figures given in Mr. Esson's paper and the load indicated by equation (3) shows this, and under these conditions the brushes certainly have a position different from that required when the field is to be nought, or almost nought, at the pole corners. The fact is, Mr. Swinburne has to assume the lead and load the armature till it comes right, but as regards the predetermination of the exact position for the brushes under the conditions of practice, little progress has yet been made. In this article it has been assumed that the brushes are just under the pole tips, for that their position depends upon the pole angle is certain. But that the induction in the cross field as given by our equations assuming this position, is correct we are not so sure. The margin between the theoretical limit and the practical loading is so large, however, that a slight variation in the angle of lead produces quite an inconsiderable effect as far as sparking is concerned.

(To be continued.)

PHYSIOLOGICAL EXPERIMENTS WITH ELECTRIC CURRENTS.*

By EDWARD TATUM, M.D.

THE following experiments were arranged for the purpose of ascertaining how definite a relation might exist between density of current and fatal result. Dogs were the only animals used. The uniform routine of procedure was to begin, in the case of each dog, with the closure of a current that was not expected to be fatal; and then to follow that with closures of successively increasing strength until the heart was arrested. The duration of each closure was one second. And a subsequent dose was not given until the heart and respiration were apparently quite restored. The electrodes were flexible frames of fine copper wire, covered with a thick coating of absorbent cotton, and were wet with weak salt solution. A round one about two inches in diameter was bound on the forehead, and a rectangular one, one-and-one-half by six inches, was bound upon the inner aspect of the right thigh as close to the body as possible.

The electrical resistance with similar connections, had previously been recorded in 12 dogs of varying weights and build. The highest figure was for a black and tan terrier of about 12 pounds, and reached rather more than 500 ohms; the lowest, for a stoutly-built dog of about 80 pounds, was slightly less than 200 ohms. The resistance offered by dogs between 30 and 40 pounds is, with fair contacts, generally very near to 300 ohms. These resistances were obtained by dividing the total number of volts of potential difference by the number of ampères actually passed. They include, therefore, the obstruction offered by the electrodes, the contacts, and counter electromotive force.

It has clearly been shown by experiments previously published that the fatal mischief done by electrical currents to dogs is done chiefly or entirely within the actual substance of the heart.

I have, however, not thought it worth while to attempt in this place any estimate of the current density to which the heart has been subjected, but have confined my calculations in the following tables, to (1) the average density in the smallest transverse section of the neck (expressed in decimals of an ampère per square inch); (2) the average density in the greatest transverse section of the chest; (3) the ratio of current strength to body weight.

The strength of alternating currents is expressed in virtual ampères and read on a hot-wire ammeter.

The results would, doubtless, have been more satisfactory if, in every case, the interval between the strongest current survived, and that proving fatal, had been less than it now is. Still, it is thought that the results, as presented, are at least sufficient to give a fairly definite notion of the order of magnitude of the currents of different sorts that are required to produce fatal results.

Besides the summary given in Table V., I would call attention to the following points of interest:

First. That 300 reversals per second are no more injurious than 120, with currents of the same virtual strength.

Second. That, when reversed 300 times per second, a current to be fatal need not be of more than half the virtual density of a continuous current for the same result. This is the lowest ratio between the respective "least fatal densities" given in Table V., and occurs when chest densities are regarded. If neck densities or weights are regarded, the lowest ratio of fatal powers is about one-third.

Third. That, when dogs are thoroughly etherised, this difference between the fatal powers of continuous and rapidly alternated currents is practically abolished, the same virtual strength being required in one case as in the other.

* *Electrical World.*

Fourth. That while ether thus in some way increases the tolerance for rapidly alternated currents, it has no such power with regard to continuous currents.

Fifth. That, in estimating the killing power of a continuous current, the relative position of the poles is probably without significance.

TABLE I.—WITH ALTERNATING CURRENT.

300 reversals per second.

No.	Weight. Lbs.	Current each closure 1 second.	Average current density. In neck.	Average current density. Chest.	Ampères per pound of body weight.
		Ampères.			
1	8½	·08	·015	·007	·0094
		·18	·035	·015	·0212
2	11¼	·1	·018	·006	·009
3	2· ½	·11	...	...	...
		·15	·015	·006	·0063
		30	·03	·012	·0125
4	25	·3	·036	·012	·012
5	26¼	·1	·008	·0026	·0039
		·2	·017	·0052	·0078
6	27¾	·1	·008	·003	·0036
		·2	·016	·006	·0072
7	40	·05	...	...	...
		·17	...	...	...
		·22	·021	·009	·005
		·245	·023	·01	·0061
8	47¾	·35	·02	·008	·0073
9	51	·2	·005	·002	·002
		·1	·01	·004	·004

120 reversals per second.

10	13¾	·1	·014	·0064	·0073
11	18½	·1	·014	·0037	·0054

TABLE II.—WITH ALTERNATING CURRENT.

300 reversals per second.

Dogs Etherised.

No.	Weight. Lbs.	Current each closure 1 second.	Average current density. In neck.	Average current density. In chest.	Ampères per pound of body weight.
1	14¾	·08	...	...	...
		·15	...	...	...
		·20	...	...	...
		·29	..	...	...
		·42	·056	·019	·0285
		·435	·058	·02	·0295
	25	·03	...	...	...
		·125	...	...	...
		·225	...	...	...
		·315	·036	·012	·0126
		·45	·051	·018	·018
3	25	·1	...	...	...
		·2	...	...	...
		·3	...	...	...
		·5	·05	·018	·02
		·75	·075	·027	·03
4	40	·05	...	...	...
		·15	...	...	...
		·225	·014	·0056	·0056
		·36	·023	·009	·009
5	40	·36	...	...	...
		·50	...	...	...
		·60	...	...	...
		·715	...	...	...
		1·05	·1	·04 survived	·026

120 reversals per second.

6	15¼	·02	...	...	...
		·05	...	...	...
		·13	·017	·006	·0087
		·17	·023	·008	0111

TABLE III.—WITH CONTINUOUS CURRENT.

Furnished by Secondary Battery.

No.	Weight. Lbs.	Current each closure 1 second.	Average current density. In neck.	Average current density. In chest.	Ampères per pound of body weight.
1	9	·3	·059	·019	·033
		·42	·082	·027	·047
2	20	·3	...	...	...
		·4	·041	·015	·02
		·53	·055	·020	·026
3	36½	1·07	·074	·03	·029
4	59	·4	...	...	...
		·55	...	...	...
		·9	·044	·017	·015
		1·25	·061	·023	·021
5	66¾	·3	...	...	...
		·5	...	...	...
		·7	...	...	...
		1·1	·061	·022	·017
		1·1 2 sec	...	...	...
		1·1 2 „	...	...	...
		1·1 2 „	...	...	...
6	97½	1·3	·045	·018	·013

In Nos. 1, 3, 6, the positive pole was on the head.
In Nos. 2, 4, 5, the negative pole was on the head.

TABLE IV.—CONTINUOUS CURRENT.

Furnished by Secondary Battery.

Dogs Etherised.

No.	Weight. Lbs.	Current each closure 1 second.	Average current density. In neck.	Average current density. In chest.	Ampères per pound of body weight.
1	20	·28	...	...	...
		30	...	...	...
		·48	·049	·02	·024
		·65	·067	·03	·032
2	45	·37	...	...	...
		·52	·036	·131	·0115
		·70	·048	·017	·015

In No. 1 the positive pole was on the head.
In No. 2 the negative pole was on the head.

TABLE V.—SUMMARY.

	Alternating current. Dogs etherised. 100 reversals.	120 reversals.	300 reversals.	120 reversals.	Continuous current.	Dogs etherised.
Strongest current used	·35	·1	1·05	·17	1·30	·70
Strongest current survived	·22	·0	1·05	·13	1·1	·52
Second strongest current survived	·15	·0	·50	·0	·9	·48
Greatest density in neck survived	·021	·0	·10	017	·061	·049
Second greatest density in neck survived ...	·015	0	·056	·0	·059	·036
Greatest density in chest survived	·009	·0	·019	·0	·019	...
Strongest current, per pound, survived... ...	·009	·0	·028	·0087	·033	·024
Second strongest current, per pound, survived ...	·0063	·0	·026	·0	·02	·011
Least density in neck, fatal	·01	·014	·023	·023	·045	·048
Second least density in neck, fatal	·016	·014	·051	·0	·055	·067
Least density in chest, fatal	·004	·0037	·009	008	·018	·017
Least current per pound, fatal	·004	0051	·009	·0111	·013	·015
Second least current per pound fatal...	·0061	0073	·018	·0	·017	·02
Least fatal current ...	·10	·10	·36	·17	·42	·65
Ratio of greatest neck density, survived to least neck density, fatal... ...	·21	·0	·100	·17	·61	·49
	·10	·0	·23	·23	·45	·48

Since writing the above, Dr. Tatum has written the following interesting letter bearing on the same general subject, and especially important in view of certain experiments the results of which were recently made public in England :

"To the Editor of the *Electrical World :*

"Sir,—Electrical currents can cause muscles to contract either directly or indirectly, or through the intermediation of motor nerves. They can also cause, through the cutaneous nerves, sensations varying from a rather pleasant thrill to an intolerable pain. The reactions of these organs vary with the sorts of currents used ; and the intensity of the reaction in the case of a given organ and a given sort of current, varies to a certain, though limited, extent in proportion to the actual electrical output. These phenomena are exhibitions of normal physiological functions, and depend, for their development, upon the life and integrity of the tissues in question.

"Electrical currents may also cause the sudden death of an individual organism. Is the latter power a simple extension of the former one? Do they kill individuals by virtue of physiological excitation of muscles or sensory nerves? It seems to be generally assumed that such is the case, and that if we can find out what sort of currents will, for a given electrical outlay, most vigorously call forth this vital activity, we shall then have found the kind of current that will, with the least expenditure of energy, destroy the individual.

"It is certain, however, that the death of an individual (dog) may be produced without the intermediation of sensory nerves ; for some currents can kill quite as readily as ever after all sensibility to pain has been abolished in profound ether anæsthesia. And it is equally certain that it is not any muscular contraction caused by the current that kills. For the heart, which is the most vulnerable of all the vital organs, and which can be killed by currents that leave the other muscles and nerves apparently uninjured—the heart is actually not caused to contract by a fatal current, but is robbed of its faculty for further contraction.

"If, then, the fatal power of electrical currents has no discoverable connection with their power to excite to physiological activity in senses, nerves or muscles, what right have we to accept a comparison between the painful sensations caused by two different sorts of currents, or between their capacities for exciting muscular contractions, as the *measure* of their respective powers to destroy the function of a totally different organ? Certainly, none whatever. If one sort of current really has a greater killing power for the same mechanical equivalent it can only be established by direct experiments with currents that kill ; and the greater or less irritation which cutaneous nerves may suffer, in mild applications, is totally irrelevant."

Since the above was written the following correction by Dr. Tatum has been made :—

Permit me to correct an error in my paper on "Physiological Experiments with Electric Currents."

In reviewing the results I said : "*Second.* That, when reversed 300 times per second, a current to be fatal need not be of more than half the virtual density of a continuous current for the same result. This is the lowest ratio between the 'least fatal densities' given in Table V.," &c.

Instead of "least fatal densities" I should have written "greatest densities survived."

The ratios of least fatal densities, as given in Table V., will be seen to be, approximately, for alternating and continuous currents :—

For the neck, $\frac{1}{4\cdot5}$.

For the chest, $\frac{1}{4\cdot5}$.

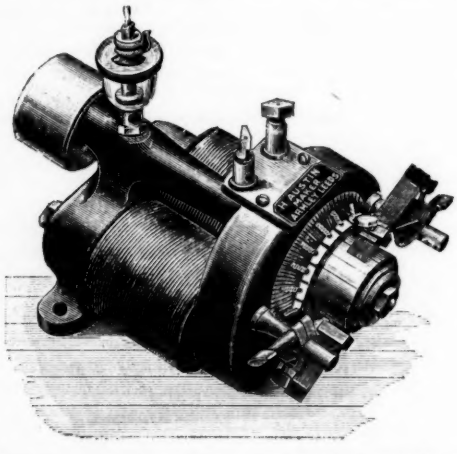
By body weight, $\frac{1}{3\cdot25}$.

Yonkers, N.Y., *May 8th*, 1890. EDWARD TATUM.

AUSTIN'S INFANT DYNAMO.

UNDER the name of the Infant dynamo, Mr. H. Austin, of Armley, Leeds, is introducing a machine which he hopes may meet the demand for small dynamos, having equal merits with the larger ones made by the leading makers, as far as regards good output for power absorbed. He commences where other makers leave off, namely, at one unit, the range of sizes being 1,000, 700, 400, 200, 100, and 50 watts. These are all made alike in every detail, differing only in size.

The armature core is made up of thin best Swedish charcoal iron rings (No. 18 B.W.G.), accurately turned both inside and outside by special machinery. The sharp corners left on in turning are all carefully ground off each separate ring, which is then coated on both sides by a varnish made up of very thin shellac varnish, in which is mixed some fine Paris plaster. The core is then built up to the required depth, the separate pairs of rings, while under pressure, being carefully tested for insulation, and mounted on a strong spider of hard brass. The core is then well insulated, and wound in the Gramme fashion. The commutator is made up of segments of brass of a special quality (all carefully insulated with asbestos or mica), and has a good wearing depth. The field magnet cores are made of best Swedish iron,



carefully annealed, and are screwed into the pole-pieces—the pitch of thread being almost microscopical—a method which gives a very good contact between the two surfaces. The yokes are very massive, having a sectional area three times that of the cores. The bearings are of very hard phosphor bronze, and are of good length. Each dynamo is fitted with a sight-feed lubricator. The used oil finds its way by suitable passages into the oil dish under the yoke of the magnets. There is only one lubricator to each dynamo, the oil entering between the two brushes and working outwards, thus keeping the bearings perfectly clean.

The armature can be taken out for examination in a few moments, it only being necessary to lift the brushes off and loosen the nut off at pulley end of spindle. The dynamos are fitted with rockers to brushes in special cases, but in most cases this is unnecessary, the required lead being given by a suitable arrangement on brush-holders, which, when fixed, are not so easily tampered with as rockers. There are no loose wires dangling about from brush-holders to terminals, and every effort is made to make the machine as simple and effective as possible, the workmanship also being of the best class.

THE TELEPHONE IN BELGIUM.

THE Belgian Telephone Company, which carries on its operations in Brussels, Antwerp, Charleroy, Ghent, La Louvrière, and Verviers, has recently published the

results of their work during 1889. They show that the position of telephonic matters in Belgium is a very flourishing one.

Up to December 31st, 1889, the number of subscribers reached 4,394, an increase of 343, or 8·46 per cent. over the previous year.

The nominal capital is 3,400,000 francs, consisting of 13,600 shares of 250 francs and 5,000 founders' shares (the value of which is not named); the actual capital subscribed is 2,635,000 francs.

The installation of the company is valued as follows :—

Local installations	1,699,129·95	francs
Interurban and international ditto...	81,541·99	„
Private ditto	11,770·31	„
Public ditto	40,956·31	„
	1,833,398·56	„

The subscriptions received in 1889 amounted to 889,451·47 francs, and other work carried out by the company in the shape of electric light wires, private installations, &c., realised 4,081·01 francs. Deducting from the net total 400,803·19 francs for reserve, there remains 287,142·91 francs available for dividends, allowing the distribution of the following :—17·50 francs per share of 250 francs, that is, 7 per cent., and 13·60 francs to each of the 5,000 founders' shares.

The era of large dividends appears, therefore, to have commenced—a fortunate circumstance; for the right to purchase the concessions at the end of 1892 is reserved by the Government, and the price of the purchase is represented by a rental equal to the mean net revenue of the last three years, increased by 15 per cent.

Let me add, that as usual, the principal organs of the Belgian Press periodically call for the acquisition by the State of all the telephones.

E. P.

NOTES.

Electric Lighting at Exeter.—At the last meeting of Exeter City Council a letter was read from the local Electric Light Company, Limited, giving notice of the company's intention to apply to the Board of Trade for a provisional order, authorising them to supply electricity within the City and County of Exeter. The letter also expressed the hope of the directors that as the company was one in which a considerable amount of local capital had been embarked and was already in active operation and supplying the light to a number of citizens, the corporation would support the application, more especially as it would be impossible for the company to meet the views of the Council with regard to underground wires until they possessed the powers to break up the streets, which would be conferred by a provisional order. It was also shown that the prevailing idea that the granting of a provisional order to the company would practically amount to the conferment of a monopoly was altogether erroneous. The Town Clerk pointed out that until they were in receipt of a draft copy of the proposed provisional order nothing could be done, and the matter was accordingly referred to the Parliamentary Committee.

Electric Lighting in Stockton.—The Stockton Corporation has obtained a provisional order to supply the electric light in the borough.

Lighting of the Royal Botanical Gardens, Manchester.—A correspondent says that the electric light will be used during the season at the Botanical Gardens, Old Trafford, Manchester. The Thomson-Houston system will be employed. The management has been placed in the hands of Mr. S. H. Heywood, and, judging from the test installation, there is every reason to believe that the result will be satisfactory.

Reckenzaun's Car in Australia.—The Melbourne *Age* of the 18th ult. contains a telegram from Sandhurst, announcing the unofficial trial of one of the new cars of the Sandhurst and Eaglehawk Tramway Company, which was entirely successful. The cars used are on the Reckenzaun system. The machinery consists of two 8 horse-power Reckenzaun motors, each driving an axle through the medium of worm gearing. The motors are collectively capable of yielding 24 H.P. The field magnet coils of each motor are divided into four equal sections, which, by means of a commutator, may be coupled in a variety of ways, so as to produce four different speeds and powers. The motors are placed under the floor of the car, being only 26 inches long, 22 inches wide, and 12 inches high. The storage cells are 72 in number, each made up of 17 plates, giving a capacity of 160 ampère hours. They weigh, with tray, &c., two tons. The car, when loaded with 30 passengers, requires five electrical horse-power, to run at seven to eight miles per hour, and nearly four times that power on a grade of 1 in 15 rise. The car is beautifully finished, and lighted by incandescent lamps. It was equipped by Messrs. Stephens, Smith and Co., of London.

A Novel Idea.—Dr. M. Krieg is establishing an electrical testing station at Magdeburg, Germany, and invites electricians to become members of the institute (testing station), paying a subscription of 20 marks per annum, for which they will receive 25 per cent. discount off the fees if any of their apparatus is tested, but the tariff is not published.

Electric Hand Lamp.—A fireman's electric hand lamp is now being introduced by the well-known fire engine makers, Messrs. Merryweather and Sons, of Greenwich and Long Acre. The battery and lamp are contained in a copper case, similar to a fireman's ordinary lamp, and fitted with a handle for convenience in carrying. The battery trough consists of six cells, and the carbon and zinc elements are carried on an ebonite plate capable of being moved vertically, so that when the light is not required the elements may be withdrawn from the exciting fluid and kept in a position by pinching screws. The electrolyte used is a special solution of bichromate of potash with sulphuric acid. The battery may be quickly recharged by unscrewing a pair of screws and dropping the bottom trough out of the case. The spent liquid is then thrown away and a fresh charge poured into the trough, this operation occupying no longer than is necessary for replenishing an oil lamp. Very powerful parabolic reflectors are provided, and the lamp, which has a duration of from two to three hours, forms an important adjunct to the outfit of a fire brigade. The lamp is also suitable for use in mines, gas works, gunpowder and chemical factories, &c. The advantages claimed for this lamp are its portability, facility in charging, capability of resting the battery when the light is not required, and its safety. The lamp is shown, among other articles, at the Royal Military Exhibition.

Tenders Wanted for Cables.—The Spanish Minister for the Colonies invites tenders for the supply of a cable to connect Spain with Cuba and Porto-Rico. The tenders are to be sent in before the end of July. No conditions of contract have been published.

Electric Fire Alarms.—An elaborate system of telephones and electric fire alarms is being established between Arundel Castle and the outlying stables, estate office, and other buildings, in order that assistance may be promptly invoked in case of an outbreak of fire.

Electric Light Fittings.—Owing to large increase of business in electric light fittings, Messrs. Faraday and Son have recently opened drawing offices and showrooms on the first floor of their premises, 3, Berners Street, as well as taking over an adjacent factory, to keep pace with the growing demands.

The General Electric Power and Traction Company, Limited.—"This company offers an excellent opportunity for those seeking a steady industrial investment, which will in time show great progress." This is the opinion—no doubt carefully considered and based upon deep knowledge of the electro-technical industry—of *Invention*, a paper whose main object, we imagined, was to sift the grain from the chaff in the field which it is supposed to cover. For a City opinion on this scheme we would advise readers to peruse the *Financial News* of yesterday, which bears out our own comments in the most complete manner.

Personal.—Mr. Frank B. Lea, B.A., Assoc. Inst. Electrical Engineers, writes to say that he has ceased all connection with *Electrical Plant*, in which he has hitherto acted as editor and manager. Mr. Lea is about to take up more active work in the way of electrical transmission of power, and although we shall lose the lively paragraphs from his pen which made our contemporary so readable, we wish him every success in his new venture.

Presentation to Mr. Bernard Drake.—The staff and *employés* of Messrs. Drake and Gorham, who now number upwards of 80, presented Mr. Bernard Drake, on the occasion of his marriage on the 28th May, with a handsome plate-chest, containing an assortment of silver plate. Mr. Drake replied: Gentlemen—I cannot tell you how much I appreciate the very handsome and useful present which you have made to me, and I value it all the more because I know what sacrifices must have been necessary to give me such a costly token of your good feeling. You all know what importance I attach to an absolute unity of interests between employer and employed, and I should like to take this opportunity of thanking you all for the very loyal way in which you have always worked for the welfare of the firm. I like you all to feel, as I know you do, that as the business increases and prospers, your individual interests are watched, and that every success which we score will tend to better your positions. Our object is, and always will be the same, viz., to do better work than anyone else, to employ better men, and pay better wages. I am pleased to say that with your assistance this policy is succeeding, and the firm is in a more prosperous condition, and has more work in hand now than at any previous stage of its existence. I hope you will co-operate with us in executing this work so that it may be a credit to us all, and that you will continue to pay the closest attention to "details," for on this, to a large extent, depend our success. I must again thank you for your kind present and good wishes.

Telegraphists in Conference.—The annual conference of postal telegraph clerks was held at Leicester on Saturday, May 31st. An official shorthand writter attended on behalf of the Postmaster-General, and consequently the names of delegates were withheld. The conference adopted a resolution calling for the reinstatement of the Cardiff clerks, on the ground that no direct charge was made against them. A proposition from Manchester in favour of affiliating the association with the Trades' Council of the United Kingdom was withdrawn, and the question referred to district centres for consideration, but a resolution calling for telegraphs to be dissociated from the Post Office and dealt with as a separate department was unanimously agreed to. The action of the Postmaster-General in sending an official reporter to the meetings was protested against as tyranical and unconstitutional.

Mr. Desmond FitzGerald on Spiritualism.—At the forthcoming Assembly of the London Spiritualist Alliance, to be held on June 12th, at the Banqueting Hall, St. James's Hall, at 7.30 p.m., Mr. Desmond Fitzgerald, M.I.E.E., M.Ph.S. (London), will deliver an address on "My Experiences in Spiritualism: a word with Sceptics and Spiritualists."

Killed by an Electric Shock.—A correspondent writes from La Rochelle, under date May 29th:—M. E. Kirchoff, employed at the electric station of Viezon, was sent to La Rochelle in order to carry out some experiments. In concert with M. Fougerat, director of the station, he was experimenting with some lightning conductors for protecting the cables which distribute the light to the town. M. Fougerat was in the machine room; M. Kirchoff, with two electric wires, was a little behind him. The two wires at their ends had been stripped of their insulating material to a length of 20 centimetres. The end of one of the wires was attached to a copper tap placed over a basin containing a little water. In order to make the projected experiment Kirchoff had to put in contact, in order to close the circuit, the other wire with that which was on the tap. One experiment had already been made, and, in order to see whether it had succeeded, Kirchoff had gone to the machine room, inadvertently letting the wire which he held in his hand fall into the basin. On his return, to recommence his experiment, he wished to again get hold by the end of the wire which had fallen into the basin; but instead of taking hold of the part which was covered with the insulating material, he seized the uncovered part and at once fell to the ground. A few moments afterwards he was found dead, still holding the wire in his hand, which was shrivelled and covered with deep burns.

Prize Competition.—The Belgian Society of Electricians offers a prize of 500 francs for the best manual on electricity for the use of electrical foremen and mechanics; MSS. are to be sent to M. Lagrange, the secretary, rue Vilain XIV., No. 26, Brussels, before 1st May, 1891. The jury will present their report on the 15th July, 1891, when the award will be made.

Soon to Emulate the Dodo.—The Philological Society of Massachusetts hopes, by means of the phonograph, to preserve the language and vocal characteristics of the Passamaquoddy Indians, a race which is becoming extinct. Who has not heard the exquisite poem commencing:—

> Sweet maiden of Passamaquoddy,
> Shall we seek for communion of souls!
> Where the deep Mississippi meanders,
> Or the broad Missouri rolls?

Sheep-shearing by Electricity.—A trial with the Wolseley sheep-shearing machine was made the other day at Lord Wenlock's home farm at Escrick, before a large number of farmers from the surrounding district.

Cuttriss and Company.—Owing to the increasing demand for their motors and dynamos, Messrs. Cuttriss and Co., formerly of 72, New Briggate, Leeds, have found it necessary to move into larger and more convenient works, where they will have facilities for the manufacture of heavier machines than those to which their attention has been chiefly given hitherto. Their new address is Elmwood Electrical Works, Camp Road, Leeds.

F. Geere Howard.—As announced in a former number, this gentleman's manufacturing business has been disposed of to Messrs. Appleton, Barbey and Williamson. Mr. Howard now informs us that he intends devoting himself entirely to contracting work, of which he has at the present time a large amount on hand. For greater convenience, he has removed to 18, Berners Street, W.

Tenders Wanted.—The Corporation of Swansea invite tenders for the execution and maintenance of all the necessary works for supplying electricity within the borough, in accordance with the provisional order obtained for the purpose by the Corporation. Further particulars will be found in an advertisement. The Magistracy of Copenhagen also advertise for tenders for an electrical central station.

Tubes and Fittings.—Joseph Aird, Wellington Tube Works, Great Bridge, Staffordshire, announces a reduction in the price of tubes and fittings of 5 per cent. gross.

Fruits of Liquidation.—The *Financial Times* says: The pleasures of liquidation have received a fresh illustration in the case of the Phœnix Electric Light and Power Company. From the liquidator's report, which will be explained to the unfortunate shareholders at a meeting called for the 30th inst., it appears that all the money he has been able to scrape together, including the magnificent sum of £125 received from the vendor, "in settlement of claim for return of purchase money," amounts to £1,617 4s. 10d. But let not anyone who has a claim on the company indulge in the pleasure of anticipation. Out of a total list of debts and claims sent in, amounting to £25,105 17s., only £659 13s. 1d. were "admitted," and even these chosen few only get 3s. 9d. in the pound. This absorbs £123, which is all that is available for distribution out of the £1,617 4s. 10d. which found its way into the liquidator's hands. That gentleman himself absorbs £285 7s. 2d., and the whole of the balance is swallowed up by costs of liquidation and other law charges. Truly the shareholders cannot be blamed if they exclaim "Save us from our friends."

Re The Whitehall Electric Supply Company.—The *London Gazette* announces that a general meeting will be held on July 4th, in order that the liquidator may produce his account of the winding up of the company.

Electrical Exhibition at Helston.—On Saturday evening last there closed a very attractive exhibition at Helston, some thousands of people having visited it during the few days it was open at the Epworth Hall. A special feature was the show of electrical apparatus and appliances by Mr. W. Slade Oliver, jun., electric light engineer, of Falmouth, consisting of instruments used in testing and measuring electric currents, electric motors, driving engines, sewing machines, &c., and a large collection of telephonic apparatus lent by the Western Counties and South Wales Telephone Company.

Liquidation.—The following letter has just come to hand:—"I write to enquire whether, through the medium of your valuable journal, any information can be obtained respecting the liquidation of the Electrical Apparatus Company, late of 4, Charing Cross? Surely some distribution of assets should have been made ere this?—ONE OF THE CREDITORS."

Progress at St. Austell.—The private installation, erected by Mr. Veale some three years ago, is now bearing fruit. Several public and private buildings are lighted, and a further development is expected.

New Edition.—We hear the demand for Maycock's "Practical Electrical Notes and Definitions" (Spon) has been so extensive that a second and greatly enlarged edition will be issued shortly.

The Lighting of St. Pancras.—The London County Council has given consent to the vestry of St. Pancras to borrow £10,000 for the purchasing of a site for an electrical installation.

Obituary.—Major-General Frederic Brine, who died on Friday last, and who has done much good in India, Japan and China, both as a soldier and a philanthropist, will also be remembered in connection with ballooning. One of his adventures in attempting to cross over to France in a balloon, when he was picked up in the Channel, will still be fresh in the memory of our readers. He was one of the passengers in the memorable trip to Calais and back in the electric launch *Volta*, which was organised by Messrs. Stephens and Reckenzaun some four years ago.

Panic in a Theatre.—On Wednesday evening the performance at the Théâtre Française, Paris, was disturbed by an occurrence which resulted in a panic. The conductors carrying the current to supply the chandeliers seem to have come together, and the light was consequently extinguished, and sparks fell among the audience. The incident caused great excitement, although it appears that no damage occurred.

The Government and the Telephones.—The Edinburgh Chamber of Commerce has sent a memorial to the Treasury urging the Lords Commissioners to exercise their right to take over the telephone system now, and not to delay their decision for a further period of seven years. The Chamber adduces the following reasons in support of their memorial:—(1) That in the event of the Government not purchasing, and at the same time continuing to grant licenses to other parties, great confusion and additional complication during the next seven years will be the result; (2) that the Government will purchase proportionately much cheaper now than in seven years hence; (3) that in regard to way-leave, there would be great saving of expense and long-spans avoided, thereby reducing the risk of accident; (4) that the telegraphic revenue, which is now suffering from telephonic communication, would be sustained and increased by the additional revenue arising from the extended telephonic system, and by economies which will arise from the two systems being operated in harmony.

English Work in Calcutta.—We hear that Messrs. Mavor and Coulson have just secured an important electric lighting contract in the City of Calcutta. The contract is for the lighting of the extensive suite of offices belonging to the British India Steam Navigation Company, Glasgow and London.

American Society of Mechanical Engineers.—This society has taken possession of its new home at No. 12, West Thirty-first Street, New York. In addition to the usual club rooms and offices there is a large auditorium with seating capacity for over 200. The place is lighted throughout by the electric light and provided with a telephone service.

Crompton and Company v. the Elieson Electric Company.—This case came before Baron Huddleston in the Queen's Bench Division on Wednesday, when the plaintiff's claim for £454 8s. in respect of goods sold and delivered and work done and materials supplied to and for the defendant company, between May 1st and November 30th, 1888, was agreed to by the defendants on the plaintiffs agreeing to strike off £70. The hearing of counter claims commenced on Thursday. Mr. Finlay, Q.C., M.P., for the Elieson Electric Company, without specifying the amount, said the damages claimed were heavy. The Elieson Company sued *inter alia* in respect of damages sustained by them to their credit and reputation owing to the breakdown on the 10th, 11th, and 12th September, 1888, of their system of electric locomotives, while being used experimentally, under arrangement with the Metropolitan Tramway Company, upon a portion of that company's line between Stratford and Manor Park, which breakdown they alleged to be owing to Messrs. Crompton and Co.'s negligence. His lordship, after considerable argument, disallowed the evidence on this head, ruling the alleged damage to be too remote. Evidence was next gone into to show the profits the Elieson Company would have made if the running arrangements referred to had not been discontinued by reason, as they alleged, of Messrs. Crompton and Co.'s negligence, and the further hearing adjourned till to-day, Friday. We shall probably refer to this subject at greater length in our next.

Bank Lighting.—We learn that the City Bank, in Threadneedle Street, is to be electrically lighted by Messrs. Strode and Co.

Charlesworth, Hall and Company.—This firm has appointed as its agents in London Messrs. Ewen & Co., of 37, Walbrook.

Electric Boats at Edinburgh.—The electric launches, which were described on page 408 of our issue of April 11th, are now running from Fountainbridge to the Exhibition, under the superintendence of Mr. Dickie, the representative of the Electric Traction Company.

Opposition to the Central London Railway Bill.—There is likely to be an attempt to throw out this Bill when it comes on for reading in the House of Commons to-day. Mr. Seager Hunt, acting on behalf of his Oxford Street constituents, will move its rejection.

NEW COMPANIES REGISTERED.

Bishops Stortford Electric Light and Steam Laundry Company, Limited.—Capital, £10,000 in £1 shares. Objects: To carry out in the town of Bishops Stortford, or elsewhere, the business of electric lighting, and to produce and supply electricity, electrical currents and force, and also establish a laundry and wash-house, and to carry on the trade of a cleaner and scourer. Signatories: Major R. B. Dalby, O. Gray, T. Gilbey, A. J. Gwynn, 1 share each; R. Lock, 2 shares; Hy. Copley, 2 shares; J. A. Findley, 3 shares; all of Bishops Stortford. Registered 28th ult. by Acklands and Nockolds, Bishops Stortford, without special articles of association.

Dick Kerr and Company, Limited. — Capital £160,000, in £5 shares. Objects: To manufacture railway and tramway and appliance, and to carry on business as engineers, electricians, and contractors for railways, tramways, and other undertaking. Signatories (with one share each): F. Mannelle and J. Kerr, 101, Leadenhall Street; J. Flett, 13, Cavendish Road, S.W.; J. W. Carr, 54, Norroy Road, Putney; A. M. Allison, 20, Lebanon Gardens, Wandsworth; J. A. J. Smith, 22, Relf Road, Peckham Rye; J. Leigh, 54, Thurlow Road, West Dulwich. The first directors are Major-General C. E. Webber, C. Thornton Cayley, F. Mannelle, and J. Kerr. Qualification, £500 in shares. Mr. John Kerr is appointed managing director for five years at a salary of £1,200 per annum. The other directors will be entitled to remuneration at the rate of £200 per annum each, with an additional £100 for the chairman. Registered 31st ult. by Linklater and Co., 2, Broad Court, Walbrook.

New Electric Fire Lighter Company, Limited.—Capital, £10,000 in £1 shares. Objects: To purchase and carry on the business of the Patent Electric Fire Lighter Company, Limited, and also the patent rights and other assets of such business and certain leasehold premises at Stratford, Essex. Signatories (with 1 share each): F. Edenborough, 14, Lansdoune Road, Tottenham; R. W. Parker, 3, New London Street; J. W. Warter, 24, Crutched Friars; S. Smith, Marsh Gate Lane, Stratford; J. G. Brett, 3, New London Street; H. Stevenson, 50, Eastbourne Terrace; H. Joseph, 13, Sandringham Road, Dalston. Registered 3rd inst., without special articles, by Heath, Parker and Brett, 3, New London Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Western and Brazilian Telegraph Co., Limited.—The annual return of this company, made up to the 23rd ult., was filed on the 30th ult. The nominal capital is £1,500,000, divided into 72,127 shares of £15 each and 55,746 shares of £7 10s. each; 119,920 shares are allotted, namely 64,174 of the £15 shares and 55,746 of the £7 10s. shares, upon all of which the full amount has been called. The calls paid amount to £1,380,705. The sum of £565 has been paid upon 75 shares forfeited. Share warrants comprising five shares each are outstanding to the amount of £7,125. Share warrants comprising one share each are outstanding for £270. Share warrants comprising 42 shares, representing £630, have been surrendered since the 1st of January.

West India and Panama Telegraph Co., Limited.—The annual return of this company, made up to the 21st ult., was filed on the 28th ult. The nominal capital is £2,445,630, divided into 200,000 ordinary, 34,563 first preference, and 1,000 second preference shares of £10 each. The shares taken up are 88,321 ordinary, 34,563 first preference, and 4,669 second preference, upon all of which the full amount has been called and paid, the subscribed capital thus being £1,275,530.

Anglo-Portuguese Telephone Company, Limited.—The annual return of this company, made up to the 22nd inst., was filed on the 28th ult. The nominal capital is £75,000 in £1 shares; 50,000 shares are allotted as fully paid up, and share warrants are outstanding representing £4,020.

House-to-House Electric Light Supply Company, Limited.—The annual return of this company, made up to the 19th inst., was filed on the 30th ult. The nominal capital is £350,000, divided into 69,900 ordinary and 100 founders' shares of £5 each; 8,322 ordinary and 100 founders' shares are taken up. Upon 7,322 shares the full amount has been called up, and 1,000 ordinary and 100 founders' shares are considered fully paid. The calls paid amount to £36,610.

Electrical Engineering Corporation, Limited.—The statutory return of this company, made up to the 22nd ult., was filed on the 24th ult. The nominal capital is £150,000, divided into 29,600 ordinary and 400 founders' shares of £5 each. Of the former, 11,517 are taken up, and of the latter 16 are allotted. Upon 1,910 ordinary shares £2 15s. per share has been called, upon seven shares the full amount has been called. as also upon the 16 founders' shares. 9,600 ordinary shares are considered fully paid. The calls paid amount to £4,967 10s., and unpaid to £400. Registered office, 3, Prince's Mansions, Victoria Street.

Buckingham Electric Light and Power Supply Company, Limited.—The final meeting of this company was held on the 28th ult., when an account was given showing the manner in which the winding-up has been conducted and the property of the company disposed of.

CITY NOTES, REPORTS, MEETINGS, &c.

The Western Counties and South Wales Telephone Company, Limited.

THE fifth annual ordinary general meeting of the shareholders in the Western Counties and South Wales Telephone Company, Limited, was held last Friday at the Grand Hotel, Bristol, under the presidency of Mr. Charles Nash. The report, of which an abstract has appeared in the ELECTRICAL REVIEW, was taken as read.

The Chairman, in moving the adoption of the report, said: It would be seen that the capital expenditure to the end of 1889 was £139,993 16s. 8d., and the gross revenue to the same date was £39,046 19s. 6d. The whole of the preliminary expenses had now been cleared off, and not only had the plant been fully maintained and renewed, but it had in many cases been improved at considerable expense by the substitution of the more efficient and durable copper and bronze wire for iron. The directors felt some disappointment that the result of the year's work did not enable them to recommend a dividend on the ordinary shares; it was, however, proposed to add £500 to the special reserve fund, increasing it to £1,700. One principal cause of the small amount of net revenue was mentioned in the report, viz., the heavy necessary expenditure on trunk lines. The total expenditure on trunks up to the end of 1889 was, in round figures, £38,000, and this large outlay was only now beginning to be remunerative. It was gratifying to note that the use of the trunk system was increasingly popular amongst the company's subscribers and the public. The increase in messages was not confined to Exchange subscribers and renters, but the outside public also largely used the call offices, the number of these latter calls having increased from

273 in December, 1887, to 1,772 in December, 1889, and to 1,968 in March, 1890. The total number of calls on the company's trunk lines had been as stated below, showing a monthly increase of 442 from September, 1887, to March, 1890. The large increase in calls during the current year gave confident promise of a further advance in this percentage. As yet the trunks had not been a direct source of profit, although the progressive increase in the monthly earnings, and the steady improvement in the percentage, proved that they were no longer altogether unremunerative; but the indirect value of the trunk system in extending the Exchange business of the company was very great. It was not merely in active business towns like Cardiff and Newport, where the calls amounted to several hundreds a day, that the value of the trunks was shown; but in quiet residential places like Bath, and in business places like Gloucester, where the value of the telephone to many of the subscribers was chiefly the power of communicating with Bristol, Cardiff, and other places; thus in many cases the trunk not only brought in its own revenue but led to exchange subscribers at each end. This experience made them anxious to extend trunks still further, as they were confident that many places, which were at present quite unproductive, would show a fair amount of business if connected with one or more of their leading centres. Worcester, for instance, had been a disappointing place. They had lately opened an exchange at Weston-super-Mare, and had already a fair number of subscribers, but they would not have obtained them without the promise of immediate trunk connection with Bristol. On completion of that line, which was now in a forward state, they looked for a large increase in the business at Weston-super-Mare. It was also important to complete the interval between Newton Abbott and Weston, bringing Exeter, Plymouth, and Torquay into direct communication with them. The effect of this would doubtless be to still further increase the Weston business, and that of Exeter and other places; and it would give the opportunity of opening exchanges at Bridgwater, Taunton, and possibly at Wellington, Dawlish, and Teignmouth, with a fair prospect of business. Shrewsbury was another place where a trunk connection was much wanted. Salisbury was at present quite isolated, but by the construction of a trunk line from Bath, *vid* Bradford, Trowbridge, Westbury, and Warminster, and continued to Winchester, these places would be put into direct communication with Bournemouth, Southampton, and Portsmouth, and with the whole of the Bristol and South Wales districts, and a fair amount of business would doubtless result. Without this trunk connection they had hitherto found it hopeless to establish an exchange at Salisbury. With it they might expect fair business there, and probably at Trowbridge and other towns. Another cause of the smallness of the balance was that during the year 1889 the progress of their exchange and private line business was less rapid than in 1888. The increase in ordinary receipts in 1888 was £99 per week, and that for 1889 £74 per week, making a difference of about £1,300 in the year. It was not easy to account for this, but it was certainly not to be taken as a sign that the use of the telephone had nearly reached its limit, for during the present year the advance at several of their large centres had been very rapid. For instance, Bristol had increased at the rate of £11 a week, against £7 a week last year, and Cardiff at the rate of £18 a week, against £13 last year. Considering the general use of the telephone, he could not doubt that it would be greatly extended in this country. There was still much ground unworked. For instance, Falmouth and Truro were now asking for an exchange, and many other towns might by degrees desire not to be left out of a system which was spreading over the country.

Mr. H. Fedden seconded the resolution.

Col. Savile supported the resolution.

The Chairman then moved: "That a dividend of 6 per cent. per annum upon the amounts paid up on preference shares to the 31st of December, 1889, be declared, and that the amounts already paid by the directors on account of such dividend, being the whole amount, be approved and confirmed."

The motion was seconded and carried; Mr. Thomas Poll and Mr. Henry Fedden, retiring directors, were re-elected.

The Chairman moved that the sum of £500 be added to the reserve fund, making a sum total of £1,700.

The resolution was adopted.

The remuneration of the auditors for the year 1889 was fixed at 95 guineas, this proposition being submitted by the chairman, and seconded by Mr. Read.

The following resolution was then adopted: "That the remuneration of the directors be fixed at the sum of £500 for the year 1889."

At the close of the ordinary meeting an extraordinary one was held, for the purpose of making certain minor alterations in the articles of association.

The Hastings Electric Light Company.

THE annual general meeting of the Electric Light Company was held on Wednesday afternoon of last week, at the office, Earl Street, Hastings, Mr. H. M. Baker, J.P., presided, and there were also present: Messrs. Woodhams, F. A. Langham, F. J. Parsons, Roddis, J. Reeves (directors), A. Bray, Bragg, James, and Burton (secretary).

The Chairman, in moving the adoption of the report, referred with satisfaction to the obtaining of their provisional order, by the increased powers granted to them, under which he said they would be in a better position than before. He then mentioned the fact that the Town Council had at last arrived at the conviction that it was desirable to light the town by electricity, and the speaker expressed himself of opinion that the adoption of the electric light in the town would be a great advantage. With reference to the granting of their provisional order, he thought that they owed a great deal to the legal skill which Mr. Langham had exercised in the matter. He then referred to the fact that during the last eight years the directors had had much anxious work, and although they had not had remuneration, still they were gratified, and, he might say, satisfied, with the success which the electric light had at last obtained in the town. He considered that at present their company stood second to none of the provincial electric light companies in the country. Alluding to the resignation of Captain Hennah from the office of secretary, the Chairman said that, like a true captain, he had not left the ship until it was in still waters. He thought that in Mr. Burton they would have a most efficient secretary. He had much pleasure in moving the adoption of the report, and the payment of a dividend of 3 per cent. Amongst the many adverse criticisms which they met with was that they had only declared a dividend on paper, but on that occasion that attack could not be made, for they now had the money, and the dividend would be paid at once.

Mr. Bragg seconded the adoption of the report.

The report was unanimously adopted, and the Chairman said that the next business was the election of directors. Messrs. Noakes and Parsons retired this year, and he pointed out that these gentlemen had consented to remain with them if it was their pleasure.

Mr. Bray thought they should avail themselves of the opportunity of having two such good business men as directors, and moved their re-election.

Mr. Roddis seconded, thinking the company could not have two better men.

The proposition was unanimously agreed to.

Greenwood and Batley, Limited.

THE second ordinary general meeting of the proprietors of the above company was held last Friday afternoon at the offices, 16, Great George Street, Westminster, Mr. Arthur Greenwood (chairman of the company) presiding.

The Secretary (Mr. G. Hagger) having read the notice convening the meeting,

The Chairman moved the adoption of the report, which stated that the balance available for dividend amounted to £33,073 3s. 10d. The sum of £46,873 18s. 3d. was expended last year in carrying out the extensions and additions to buildings and plant. The works at Leeds were in excellent order. The result of the working of the first year proved fairly satisfactory. They had increased their sales by one-third during the past year. With such a large increase of business they naturally required more capital, and the shareholders were asked to sanction a further issue which the directors thought was absolutely necessary for effectively carrying on the work of the company. He concluded by moving the adoption of the report and statement of accounts.

Admiral P. H. Colomb seconded the resolution, which was unanimously carried.

The Chairman then moved that a dividend at the rate of 7 per cent. per annum on the preference shares and 10 per cent. per annum on the ordinary shares be declared.

The motion was seconded and adopted.

The meeting was then made extraordinary, when a resolution was submitted by the Chairman for the purpose of making a further issue of capital to the extent of £44,000, viz., £16,000 in 7 per cent. cumulative preference shares, and £28,000 in ordinary shares, to be offered in the first instance *pro rata* to the shareholders at moderate premiums.

The propositions of the board were adopted, and the proceedings terminated with the usual vote of thanks to the chairman.

Brazilian Submarine Telegraph Company, Limited.—The Directors have declared an interim dividend of 3s. per share, free of income tax, at the rate of 6 per cent. per annum, for the quarter ended March 31st last, and payable on the 24th inst.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended May 30th, amounted to £4,171.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of May were £4,404, as compared with £3,513 in the corresponding month of last year. The receipts for the month of February estimated at £3,310 realised £4,391.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of May were £2,244, against £2,040 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of May, 1890, amounted to £41,230, as against £41,064 in the corresponding month of 1889.

The Eastern Telegraph Company, Limited. The receipts for the month of May, 1890, amounted to £53,373 against £52,701 in the corresponding month of last year.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 31th May, are £3,184, as compared with £3,033 in the corresponding period of 1889. The February receipts, estimated at £6,619, realised £6,755.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 30th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,262.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of May, 1890, were £6,075.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (May 29).	Closing Quotation. (June 5.)	Business done during week ending June 5, 1890. Highest.	Lowest.
£						
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 —101	98 —101	100	...
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51	50	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	86 — 87	86¼— 87¼	87¼	87
2,725,420	Do. do. Deferred	Stock	15⅝— 16½	15½— 16		
130,000	Brazilian Submarine Telegraph, Limited	10	11⅞— 12¼	11⅞— 12¼	12⅛	11 13/16
99,000	Do. do. 5 p. c. Bonds...	100	101 —103	101 —103		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1996	100	106 —109	106 —109		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	2⅝— 2⅞	2⅝— 2⅞	2 13/16	2½
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1¾— 2	1¾— 2⅛	2 1/16	1¾
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	½— ¾	½— ¾xd		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5⅝	5¼— 5⅝		
16,000	Cuba Telegraph, Limited	10	11¼— 11⅝	11⅜— 12½	12⅛	12
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½		
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼		
6,090	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	10⅜	10⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½— 14	13⅜— 14½	14¼	13⅞
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	14¾— 15¼	15¼	14⅞
200,000	Do. 5 p. c. Debs. (1877 issue), repay. Aug., 1899	100	108 —111	108 —111		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110		
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13½— 14	13⅜— 14½	14½	13⅜
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	101 —103	101 —103		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	103 —106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106	103 —106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	102 —105	102 —105		
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅜— 5½	4⅜— 5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	4⅜— 5¼	4⅜— 5½	5 3/16	4⅞
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2¼— 2⅜	2¼— 2⅜		
180,227	Globe Telegraph and Trust, Limited	10	8⅛— 8⅞	8⅛— 9¼	9¼	8 13/16
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14 13/16
150,000	Great Northern Tel. Company of Copenhagen	10	15⅜— 16¼	15⅜— 16¼	16	15⅞
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	102 —105	102 —105		
250,000	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12½— 13½	12 — 13 xd		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12 xd		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	19 — 20	19½— 20½	19⅞	19⅝
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	103 —105		
17,000	Indo-European Telegraph, Limited...	25	38 — 40	38 — 40		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	5¼— 5⅝	5¼— 5⅝	5½	...
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5⅞— 6⅛	5⅞— 6	6	5½
49,825	Do. New Nos. 386,876 to 436,700	5	5½— 6	5½— 6	5 9/16	5½
15,000	Do. 6 p. c. Cum. 1st Preference	10	12½— 12¾	12½— 12¾	12⅝	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10½— 10⅝	10½— 10⅝		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜	¼— ⅜		
9,000	Reuter's, Limited	8	7½— 8	7½— 8		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ...	¼— ...		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	3¼— 3⅜	3¼— 3⅜		
3,381	Submarine Cables Trust	Cert.	110 —115	110 —116	114⅜	114⅛
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	5¼— 5⅜	5¼— 5⅜	5⅜	5¼
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	45½	44⅜
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 — 104	101 —104		
55,000	United River Plate Telephone, Limited	5	4½— 5	4½— 5		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10	9½	...
300,000	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	100	99¼
30,000	West Coast of America Telegraph, Limited	10	5½— 6¼	5½— 6½	6¼	5⅝
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	115 —120	111 —116	116	112
64,572	Western and Brazilian Telegraph, Limited	15	9¾— 10¼	9¾— 10¼	10 1/16	10
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 6⅝	6½— 6⅝	6⅝	6½
26,986	Do. do. do. 5 p. c. Deferred	7½	3½— 4	3½— 4		
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107	106¼	...
88,321	West India and Panama Telegraph, Limited	10	2⅜— 2⅝	2⅜— 2⅝	2 9/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11 — 11½	11 — 11½	11 5/16	11¼
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	12½— 13½	12½— 13½		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1¾ — 2¼	1¾— 2¼		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 6⅞—7⅛.—Electric Construction Corporation (£10 paid), 9¾—10⅛.—House-to-House Company (£5 paid), 5—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—3.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-.

BANK RATE OF DISCOUNT.—3 per cent. (17th April, 1890).

ELECTRIC LIGHT IN NEWCASTLE-UPON TYNE.

GREAT interest must be attached to the doings of the electrical companies in Newcastle, seeing that they are probably in a more advanced state than any other companies which are likely to have powers for lighting towns. Many difficulties have been overcome since their inception; at one period their prospects looked very overcast. Both companies were able to supply the light, but owing to legal points the necessary mains could not be laid. However, the Board of Trade smoothed matters, and work was proceeded with. The Newcastle Electric Supply Company has erected a commodious and convenient central station in Pandon Dene. The situation is singularly fortunate, near to the centre of Newcastle, and hard by the station at New Bridge Street. Here are furnished two Robey boilers of 200 I.H.P. supplying steam to two horizontal engines by the same firm of 60 H.P. nominal. Each pair of engines drives a Mordey Victoria alternator with Victoria exciter coupled on the same shaft. Instead of the usual belting for driving, cotton ropes are used, which have been adopted in more than one central station with great success. The dynamos work at an electromotive force of 2,000 volts, the current, by the means of transformers, supplied to the houses of consumers at a pressure of 100 volts, or even less. The cables used are concentric, and are laid below the pavement in 3-inch cast iron pipes with specially designed junction boxes. We understand some little improvement in this direction has been made by the company. Great attention has been paid to the fittings of the central station, and it presents a particularly bright appearance. At the further end of the building are placed the voltmeter, ampèremeter, &c., and arrangements are being made for fitting an elaborate switchboard. Although being one of considerable size, the station has been already found insufficient, and the company is busily engaged erecting a third boiler, engine and dynamo, in a newly-erected section, and even the extra power forthcoming from this extension will shortly, it is expected, be consumed. Each consumer is required to wire his own house, and there are many firms in Newcastle who are willing and able to do this in a satisfactory manner. The company, however, takes the precaution, before supplying the current, to send round an engineer who thoroughly inspects the work done, so there can be little danger of scamped work leading to accidents. Current is supplied to consumer at the low figure of 4½d per Board of Trade unit. This is 25 per cent. dearer than gas in Newcastle, notwithstanding this fact, consumers prefer the electric light on account of its greater purity, which can be better appreciated in a smoky town like Newcastle.

Although situate in another portion of the town, the second company, the District Company, has equal powers in many streets. Substantial premises have been built by this company near the riverside. The machines employed are Parson's steam turbo-electric generators, in which turbine, alternator and exciter are all mounted on one bed-plate, one shaft carrying the revolving parts of all. These machines are run night and day, and work at an electromotive force of 1,000 volts transformed to 100, in like manner as the other company. At the request of the Public Lighting Committee this company recently erected one or two arc lamps in prominent places in the streets so that they might judge of the effects for street lighting, and it is said great satisfaction was given to the committee. The price charged per unit is more than the other company, 6d. per unit being charged; as, however, stated previously, having equal powers, this makes no difference to the business done. It is the aim of this company to induce the tramway companies to adopt electric traction, in which we trust they will be successful. As showing the popularity of electric lighting in Newcastle, there has been in existence for some time past many small private installations, but these will doubtless cease running on account of the cheapness and quality of light obtainable from the companies.

THE LANE-FOX PATENTS.

THE following is a copy of the circular which the Lane-Fox Electrical Company, Limited, of 66, Victoria Street, London, S.W., is now issuing to the trade:—

"1. As some misapprehension appears to exist in the mind of the public as to these patents, we wish to point out that they are at present held by the Lane-Fox Electrical Company, Limited, subject to licenses granted to the Brush Electrical Engineering Company (as successors of the Anglo-American Brush Electric Light Corporation), the Edison-Swan United Company, and certain other persons abroad.

"2. In the case of one patent, 3,988** of 1878, for distribution, Messrs. Crompton & Co., and the Swan United Company, have obtained an exemption from proceedings for infringement of the patents prior to December, 1882.

"3. The Lane-Fox Electrical Company, Limited, has been formed not merely, as has been alleged, to collect royalties; but to carry on a general electrical and incandescent lamp manufacturing business. If the company is fairly met in the question of royalties, but a small charge will be imposed, and it is anticipated that when the question is more fully understood, the reasonableness of the company's charges will be appreciated by the industry.

"4. It should be borne in mind that the Lane-Fox patents are in no way invalidated by the long period during which they have been, or appear to have been, in suspense; nor, on the other hand, has that suspense been the fault of Mr. Lane-Fox, or designed by him with a view of entrapping companies into their use.

"5. At an early period the Lane-Fox patents were disposed of by Mr. Lane-Fox, to be worked with other patents, to the British Electric Light Company, Limited, and subsequently to the Anglo-American Brush Electric Light Corporation. Those who are conversant with the early history of electric lighting will know that until recently the principles of incandescent electric lighting were not generally understood, and though Mr. Lane-Fox himself well knew the value of his patents they were not properly appreciated by the companies who held them, and were mixed up and entangled with the claims of other patents held by the same companies for other and competing objects.

"6. In illustration of the general contemporary ignorance of the principles now stated to be obvious, it may be mentioned that when first enunciated by Mr. Lane-Fox they were received with ridicule and decried as impracticable, and that such staunch supporters of the system as Messrs. R. E. B. Crompton and W. H. Preece were at first opposed to them; even so great an authority as Sir William Thomson had for a time his doubts as to their theoretical soundness.

"7. This opportunity may be taken to correct an impression which, to our great surprise, appears to prevail—namely, that Mr. Lane-Fox confined himself, some twelve years ago, to shadowing forth the bare outlines of a scheme, the essential details of which were laboriously worked out by others. This is not true. Not only were the principles of incandescent electric lighting distinctly enunciated by Mr. Lane-Fox as stated above, but all details necessary to their efficient application were worked out, by him independently, or through his agency, during the years 1878 to 1883. Thus in his hands the system became a thoroughly working system; installations were put up at home and abroad, and when Mr. Lane-Fox temporarily abandoned electric work at the end of 1883, his system, which was ridiculed as late as 1881, was accepted and largely used.

"8. After many abortive attempts to regain possession of the patents, attempts giving rise to 'agreement' after 'agreement' (each, as it was subsequently found, adding to, rather than removing the confusion), an agreement was finally come to upon the conclusion of the recent litigation between the Anglo-American Brush Electric Light Corporation and the Edison-Swan United Company, Limited. By this agreement, dated 3rd December, 1889, each of the two litigating companies obtained a license to use the patents in the future, and an indemnity in respect of the past; but subject thereto and to certain licenses affecting the foreign patents, all the patents were assigned absolutely to Mr. Lane-Fox.

"9. In February of this year the Lane-Fox Electric Company, Limited was formed to carry out the long-postponed designs of Mr. Lane-Fox, and to vindicate his position as the inventor of the true principles of incandescent electric lighting. The company, however, do not propose to charge vindictive royalties, or in any way to attempt to impede the progress already made, even by the unauthorised use of the Lane-Fox patents.

"10. Many times in the course of his prolonged negotiations with the Anglo-American Brush Electric Light Corporation Mr. Lane-Fox was invited by competent financiers to join in the formation of a 'ring' to control to their own exclusive advantage the electrical industry. Mr. Lane-Fox declined. He wished to liberate and not to strangle the industry. Such still is his wish; and the wish of the Lane-Fox Electrical Company is the same; but as true liberty consists in justice, and not in injustice, the company will vindicate the patents, and insist upon the payment of royalties in respect of them.

"11. In pursuance of this purpose the company have formulated proposals, the terms of which will in due course be advertised; the pith of these proposals being that if those now using the patents will accept the proposed terms, or such modification of them as may be agreed upon by the middle of June next, no royalties will be claimed for the use of the patents prior to the 31st December, 1889.

"12. It is confidently hoped that the companies and the electrical industry generally, will see the fairness and reasonableness of the terms proposed, and will co-operate in giving Mr. Lane-Fox the position he can fairly claim in the electrical world.

"C. A. STEPHENSON,
"Managing Director Lane-Fox Electrical Company, Limited."

French Telephony.—The British Consul at Bordeaux mentions in a Foreign Office report that the telephone lines there, as elsewhere in France, have passed into the hands of the Government. The number of subscribers is about 450 and the subscription is about £12 per annum. The long-projected telephonic communication between Bordeaux and its outport of Pauilliac, which will be of much use for shipping, is about to be opened.

REVIEWS.

Chronological, Historical, and Heraldic Charts of the Royal House of England, from King Egbert to the Present Time. By I. A. Timmis, M.I.C.E,, &c. Henry Sotheran & Co., London.

Being more acquainted with telegraph than with genealogical lines, we may perhaps be excused, in first opening the sumptuously got up volume before us in a somewhat casual manner, for thinking that the work was devoted to the treatment of electric lighting from a decorative point of view. A closer inspection dispelled the error into which we had fallen, and revealed the fact that a most interesting book had come into our hands, but one which, to appreciate thoroughly, required a more adequate knowledge of the art of heraldic blazonry than we were in possession of.

The author states in his preface that when he sketched out some years ago, in a series of charts, the line of descent of the Royal Family of England from Egbert to the present time, he had no intention to do more than that; but as time went on he gradually added more and more collateral branches, and thus embraced, within certain limits, many of the Royal and chief families of continental Europe, as well as some of the best families of Great Britain. Next, to make the work more attractive, he decided to blazon the arms of the various families, and as the fascination of depicting heraldic devices increases by the cultivation of the science, many other details were added in the endeavour to make the charts as complete as possible.

A note is appended to each name in the pedigree, giving a concise but succinct account of the most important events in the individual's life, and also of current events in this realm, the whole series of notes thus forming an epitome of the History of England, as well as of events that happened in other countries. The record of these transactions is generally correct, but here and there—owing most probably to clerical and printers' errors—the figures given for certain dates are faulty, resulting in such a case as that of King Stephen, where the king makes an agreement with Henry to leave the latter the crown 17 years before Henry was born.

The representation on the first page, showing how the Union Jack of Great Britain is formed from the single crosses of St. George, St. Andrew, and St. Patrick, should give some useful knowledge to numerous persons. Most people know the cross of St. George, but from the number of times we have been asked to explain the Union Jack we can only infer that the majority of the public are unacquainted with the other component crosses of the flag, or if they know that three crosses are employed in its construction they are doubtful as to which is which.

Besides being a short history of England, Mr. Timmis's work shows the progress of heraldic science in its progressive development from the earliest times. Drawings of the crowns worn by successive kings are also given.

If some work of this kind could be introduced as a class-book for history we opine that the study of that subject would become a pleasant task to many who now consider it to be a most hateful drudgery.

The Glow Lamp: its Manufacture and Use in Practice. (Die Glüh lampe, ihre Herstollung und Anwendung in der Praxis). By J. ZACHARIAS. A. Hartleben: Vienna, Pest, Leipzig.

The treatise before us forms the 42nd volume of that well-known and useful series, Hartleben's "Elektrotechnische Bibliothek." In his preface the author expresses the opinion that a systematic exposition of the various methods adopted for the production of the lamp is still wanting. He hopes that his work will be of the greater service, as the still-pending litigation on the subject must ultimately come to an end, if in no more satisfactory way, yet, at any rate, by the expiry of the patents, a termination substantially in the style of that in Jarndyce and Jarndyce. The author is perfectly right in supposing that thereon the manufacture and sale of these lamps will undergo a great extension. Already he estimates the yearly production in Europe at five millions, and when gas and petroleum are used only for heating and driving motors, he calculates that the output will become tenfold greater.

The history of the glow lamp is not considered at any great length. It is shown that originally carbon filaments were not used as luminous bodies, but a platinum spiral. This was Edison's first idea, though in 1879 he seems to have adopted filaments of bamboo. The third period in the career of the glow lamp seems to be at hand when the current can be cheaply produced in private houses by means of galvanic or thermo-electric batteries, dispensing with the cumbrous dynamo.

The author recognises Edison as the first who gave the glow lamp practical utility; but not the first who devised its principle. The physical conditions of the glow lamp are next discussed, a subject on which the most singular errors have prevailed, and have been reproduced even in the writings of specialists. In the section on the materials for lamps, the author insists that the vegetable fibres used for the production of filaments should be free from fungi. A manufactory was for an entire week unable to produce a good lamp, because decomposing bamboo had been used for the work.

In the second chapter all the stages of the manufacture of the lamps are passed in review, and the necessary precautions are indicated. The third chapter treats of the applications of the glow-light. Here it is pointed out that the heat given out is only from 290 to 536 calories, whilst a gas argand for the production of the same quantity of light gives out 4,860 calories, and a large circular petroleum burner 3,360 calories. It may, indeed, be thought that in our climate the heat of gas flames can rarely be objectionable. But the heat evolved by gas burners is in the wrong place—in the upper part of the room, and like chandeliers and suspended lamps, they help to reverse the old proverb, and keep our heads hot, and our feet, relatively, cold.

In a table on the duration of glow lamps, we find that as this increases, they become more expensive in working. Thus while a lamp adapted to burn for 500 hours requires $2\frac{1}{2}$ watts, one constructed for 2,000 hours consumes 5 watts; so that the increased duration of a lamp is not all pure gain to the consumer.

This little work, though it has certain rivals in the field, may be consulted with advantage by the makers and users of glow lamps.

The chapter on the "Development of the glow lamp in a technical and commercial point of view," is exceedingly interesting. Whether the remarks on the "Bunkumphone" and the "Tuning-fork dynamo" may form the subject matter of proceedings for libel, we do not venture to foretell.

Almanach-Annuaire de L'Electricité et de L'Electrochemie. 6e. Anuée, 1890. France-Belgique-Suisse. Firmin Leclerc: Paris, 172, Rue Louis-Blanc.

This useful directory of foreign manufacturers of electrical material should be in the hands of all who have business dealings with France, Belgium and Switzerland. A great point in favour of the book is its extremely handy size.

Journal of the Institution of Electrical Engineers. No. 86. London: E. and F. N. Spon, 125, Strand.

The general contents of this number are as follows: Continuation of discussion on Mr. James Swinburne's paper on "The Theory of Armature Reactions in Dynamos and Motors," and Mr. W. B. Esson's paper on "Some Points in Dynamo and Motor Design." Paper and discussion on "Alternating *v.* Continuous Currents in relation to the Human Body," by H. Newman Lawrence and Arthur Harries. Abstracts.

The Victorian Electrical Telegraphic Journal. No. 44.

This number contains articles on "The Lighting of the Centennial International Exhibition, Melbourne, 1888 and 1889, by K. L. Murray (read before the Institution of Electrical Engineers, London); "Notes on the Measurement of Resistance," by C. Ralston. "A Talk with Learners;" "Regulations for the Departmental Telegraph Class;" "A Fault;" "Mehner Dry Galvanic Cells;" "An Electric Fence." Correspondence. In the latter the following (which is worthy of note) occurs :—

"Sir,—I became aware of a *wrinkle* lately that I am confident will be a novelty to many of your readers, and also of use. One of our telegraph inspectors gave it to me, and I am sure he will forgive me for giving it publicity. He came to my station, and found that the battery was not up to his idea of what a battery should be. He took it down, and renewed it. When it was put up again he asked me to favour him with a little sugar. Surprisedly I asked him what he wanted with sugar, thinking he had made some mistake. He quietly laughed, and said, "Get some, and I will show you what it is for." It was got, and he began to wash his hands in the usual way with soap and water, but, after rubbing the soap, he added the sugar, and immediately a good lather came. He washed his hands twice, and told me to do likewise. I did, and to my pleasure my hands came out of the wash clean and soft. He told me always to do so when working with magnesia or copper solutions, and the nasty dry feeling that usually is experienced when working with a battery is quite done away with. As I think this worth knowing, I make bold to ask you to give publicity to it in the journal. This unpleasant feeling was one of the things dreaded, as one had always to let the effect wear away, days being taken up before it disappeared.

"The inspector told me that he was indebted to Mrs. Walker, station-mistress of Drysdale, for his knowledge of it.—Yours, &c., "S. M."

The Wimshurst Electrical Influence Machine. By W. P. MENDHAM. Bristol: King, Mendham and Co., Western Electrical Works.

Coming out as this small book does almost concurrently with that of Mr. J. Gray, it will probably be overshadowed by the latter, as it is altogether smaller in dimensions and more elementary than that work. The chief aim of the author has been to describe the main features of the Wimshurst machine, and this aim has been satisfactorily effected, we think. Three-quarters of the book (64 pages) are, however, taken up with electrical experiments, which are described in every elementary treatise on static electricity.

AN OPTICAL FEATURE OF THE LIGHTNING FLASH.

By ERIC STUART BRUCE, M.A., F.R.Met.Soc.*

IN the first report of the Thunderstorm Committee, which dealt with photographs of lightning flashes, the committee called attention to the fact "that there is not the slightest evidence in the photographs of lightning flashes of the angular zig-zag or forked forms commonly seen in pictures." They also referred to the paper that Mr. James Nasmyth communicated to the British Association in 1856, in which Mr. Nasmyth says that a flash of lightning appears to him to be more correctly represented by an intensely crooked line, and he seems to doubt the existence of artist's lightning. To these apparently conclusive condemnations of the conventional idea of a lightning flash might be added the words of Mr. Ruskin in *Modern Painters*, when criticising Turner's "Stonehenge." He says :—"The white lightning, not as it is drawn by less observant or less capable painters in zig-zag fortifications, but in its own dreadful irregularities of streaming fire." It is noticeable that these words were written of Turner's picture many years before the publication of Nasmyth's paper.

But on the other side there was the evidence of one's own eyes, and those of many others, as having at times seen a zig-zag flash something very like the depiction of the artist, added to a conviction that in the conventional representation handed down from ancient times there is probably some element of truth.

It occurred to me that the explanation would be found not to be an optical illusion, but an optical reality—not the flash itself, but the optically projected image of the flash formed on clouds. But why should the projection flash be in angular zigzags? Because the clouds on which the projection is cast are often of the *cumulus* type, so as to afford an angular surface.

The image of the flash takes the angles of the uneven surface of the clouds. Having formed this theory in my mind, I proceeded to experiment, and succeeded in reproducing something very like the conventional lightning by casting the projection of a photograph of lightning on model clouds.

I have arranged on the table some model clouds presenting an angular surface.

Let the incandescent lamp represent a flash of lightning at some distance from the screen of clouds. When the light is flashed on and off, there is the simulation of sheet lightning on the cloud screen; now to transform the *sheet* lightning into *projection* lightning. To do this there must be an addition to the arrangements—a cloud with a small opening in it, somewhere between the flash and the surface of cloud upon which the projection is cast. Let a screen with one small opening represent such a cloud; when this is placed in position, and the light flashed on, there is no longer the sheet lightning, but the image of the incandescent carbon—a distorted image as it falls upon the uneven surface of the clouds. The sides of the horseshoe of white hot carbon appear to be zig-zagged.

And now to go one step further. If we make another opening in the model cloud, there will be two images formed of the incandescent filament of carbon, and likewise in nature a multiplication of openings will produce a multiplication of images of flashes. May this not explain the forked appearance so often depicted?

It may be objected that it seems inconceivable how this peculiar type of flash came to be regarded as the only type; for the image is probably not nearly so frequently seen as the flash itself. Perhaps the fact that the image of the lightning flash would not have that intense and dazzling brilliancy of the flash itself may explain this.

If any brilliant source of light, such as the arc light, be suddenly flashed upon the average human eye, that organ would not recognise the form of the source; but if the image were flashed upon a screen, any eye would distinguish the image of the white hot carbon points, and so the projection would lose the bewildering brilliancy of the flash, and its distorted form would be impressed upon the mind. The diminution of brilliancy probably also explains that other objection—that no photographic plate seems to have yet registered the zig-zag "projection" flash.

* Abstract of paper read before the Royal Meteorógical Society.

Two Churches Struck by Lightning.—A violent thunderstorm broke over Holsworthy, North Devon, recently. The tower of the parish church was struck by lightning, and the north pinnacle destroyed. Portions of the masonry fell through the roof into the nave, doing considerable damage. At Barnstaple, the tower of Holy Trinity Church was struck, smashing off one pinnacle and some coping. It would be as well to ask in these cases where were the lightning rods?

LEGAL.

King, Brown and Co. v. Anglo-American Brush Electric Light Corporation, Limited.

IN the First Division of the Court of Session, Edinburgh, on Wednesday, May 28th, was commenced the discussion on the reclaiming note by the defenders in the action by King, Brown and Co., Limited, Rosebank Electric Works, Edinburgh, against the Anglo-American Brush Electric Light Corporation, Limited, for reduction of the defenders' patent for a peculiar form of commutator and a series-shunt machine. After evidence in the outer house of the Court of Session, Lord Trayner found, with regard to the commutator, that the patent was invalid in respect that the invention claimed in the final specification was larger and different from that claimed in the provisional specification, and as to the series-shunt machine his Lordship held that it was anticipated by Varley, both by publication and usage. He therefore reduced the patents as sought, with expenses. The defenders reclaimed against this decision to the First Division of the Court and the case was opened to-day before the Lord President, Lord Adam and Lord M'Laren. The defenders were represented by the Dean of Faculty Balfour, Q.C., M.P., and Mr. Jameson, instructed by Messrs. MacKenzie, Innes and Logan, W.S., and the pursuers by Mr. Graham Murray, Mr. Dickson and Mr. Daniells, instructed by Messrs. Davidson and Syme, W.S.

Mr. JAMESON, for the reclaimers, said this was an action of reduction of Brush's patent—a patent which was taken out originally in America, but which, in so far as it was a British patent, was brought here by a communication from America, and was patented by a patent agent of the name of Hadden. It was therefore called Hadden's patent throughout the evidence; but, perhaps, it would be convenient for him to refer to it as Brush's patent. The action of reduction was brought in consequence of an action of putting to silence that was brought by King, Brown and Company in consequence of which there were threats administered to them by the Brush Company for having manufactured compound-wound or series-shunt machines. That action came before their Lordships, and there was a question whether it should proceed first or follow an action brought by the Brush Company against the Orient Company. It was suggested that King, Brown and Company should try the question by means of a reduction. Following that suggestion that reduction was brought. There were a number of grounds of reduction set forth in the record, but the grounds which were now founded upon by the pursuers resolved themselves into two or three. They said, in the first place, with regard to the commutators of that machine, that they were neither original nor useful. He did not know exactly how far the pursuers were going to maintain all their pleas; but he was attacking the Lord Ordinary's interlocutor upon the three grounds which he took up, and in his speech he would only deal with these three points. These points were, first, that with regard to the commutators of Brush's patent, in the completed specification, there was something set forth that was not sufficiently shadowed forth in the provisional specification. That was the point against them with regard to the commutators. Then, with regard to the main part of the machine, the Lord Ordinary held that that discovery was anticipated by the publication of the patent of Varley in 1876; and the third ground was that the invention was publicly used by that machine of Varley prior to the patent. Brush's patent, as regarded this country, was taken out in 1878, while Varley's was taken out in 1876; but there was this remarkable difference between them, that whereas Brush's patent had been practically used ever since, and hundreds of machines made in accordance with it, Varley's patent had never been heard of until the single machine, made in accordance with it, was disinterred from a lot of rubbish in the shop of the persons who made it, and brought forward in a previous action—an action which was settled by the parties paying the Brush Company a royalty. It was necessary before proceeding further that he should explain the nature of that electrical dynamo machine, because it would be almost impossible that he should be able to read the evidence intelligibly or refer to these points intelligibly without doing so. What he was going to say was really matter common to both sides. All these dynamo electrical machines might be described generally as machines for converting mechanical energy into electrical energy, and they were founded upon two principles, or modifications of the same principle, originally described by Faraday—namely, that if a coil of wire were revolved in the two opposite poles of a magnet a current of electricity would be set up in a wire in a direction bearing according to whether it was whirled in one direction or another, and according, also, to whether the pole was north or south. The simplest form of such a wire was shown in a production in which it was revolved between the poles of a magnet. The current set up would proceed in one direction or another, and when the wire passed from the north to the south pole the current would be reversed, that was to say, in passing along to the right it would pass to the left; and *vice versâ*. The magnets which kept up the field of magnetic force were called the field magnets. By multiplying the number of wires they multiplied the currents enormously, and whatever mode of the coil of wires, they always constituted the armature. The commutator was that by which they avoided alternating currents. The currents were taken off for practical purposes by a brush. There was always an outgoing current which, returning by the other brush, joined the armature along the shaft. When the outward current was passing along the wire the brush was resting upon the plate in connection with a wire. As it went round it first passed to the centre of indifference in which, in Brush's machine, the bobbins were cut out of action by a particular arrangement, and then passed into the sphere of the south polar line of force, in which case the current was changed and sucked into the armature. But then, although the direction of the current was changed the plate had also changed its position, and as the current changed the position of the commutator changed, and by the time it came round to the south polarity the plate of the commutator in connection with that current was at the sucking-in brush, and was consequently in the proper direction. At the same time the other coil, which had gone round to the outgoing current, was in connection with the outgoing brush, so that there was a current kept up without an alternative current as would otherwise be the case. The result was that there was always a positive current going out at the right hand and a negative current going in by the brush on the left. With regard to the commutator, he did not know what the other side were going to maintain.

Mr. GRAHAM MURRAY said he was going to maintain that not only was the commutator patent bad in respect of inconsistency between the completed and the provisional specifications, but that it was also bad in respect of prior use.

Mr. JAMESON said the Lord Ordinary was against his friend upon the latter point. His Lordship thought their commutator new and meritorious. They by no means claimed the commutator as a new electrical invention, but that it was a patent on purely mechanical grounds. Now the question which occurred after Faraday's discovery was, how were these bobbins or coils of wire to be kept in an electrical state, and the first and earliest mode was just to have a permanent magnet—a steel magnet of large size, either magnetised by loadstone or by electricity originally. Then it was found that electro-magnets were very much more powerful than ordinary permanent magnets. An electro-magnet was nothing more than a band or bar of soft iron wound round with a wire, through which a current was sent and that developed such a powerful magnet as to be far, far, stronger than any permanent magnet could be. The next form was to have an electro-magnet charged with electricity by a voltaic battery, or by a small machine. In short they got their magnetism for their machine from an independent external source by means of winding a wire and sending an electrical current through it from an external source. Then it struck some proficients that they might get the electricity to the inside magnets from the machine itself without having a machine outside as in the former case. That might be done by having a number of bobbins upon the armature devoted to that work alone. That was the nature of Wilde's machine. Then a very good idea struck some electricians—he thought there were three people who brought it out at once—and that was known as a series wound dynamo. That consisted in this, that either before or after they sent the current of electricity to do the external work, they sent a current through wires wound round the magnet so that the same current which did their external work also magnetised the magnet, and of course the advantage of that was that the more external work was done in the same series, the higher was the power got in the magnets. A series machine, however, was open to several objections. In the first place whenever there was any undue resistance to the electrical current, as for instance if the points of the carbons were burned away a great deal, and the current had greater difficulty in passing from one to another——

Lord MCLAREN: Or if you had two electric lights instead of one.

Mr. JAMESON said yes, if they had them so as to occasion a great deal of resistance—this awkward result took place, that simultaneously with the resistance which the current had to overcome, they had a great weakening of the magnetism of the magnet, and for this reason: that if the current was stopped or interrupted at any part of its course it stopped or interrupted the whole. Then if the resistance was very unduly demonstrated they would have an excessive increase of magnetism, but if the external circuit was obstructed from any cause and the light went out they would have a stoppage altogether, and great difficulty in lighting up again. Then he described the shunt system, in regard to which he said a communication was read to the Royal Society by Sir Charles Wheatstone. In a shunt machine the current from the armature was at a terminal split and led into two paths—one, a wire of less resistance, called the series, and the other, a wire of greater resistance, called the shunt wire, for it was just shunted off the main current. In that way they produced increased magnetism and greater electrical resistance. The objection to the shunt machine was that if you had the useful work of the machine increased in the parallel system, they had great loss of magnetism of the magnets. He explained that electroplating and incandescent lighting were produced by the parallel system, and in directing attention to some defects in the shunt system, he said that the result was that if they diminished the pressure of electricity at the point of bifurcation, and increased the work needing more magnetism of the magnet so as to produce a stronger electric current, they had actually less magnetism, because they had open—in incandescent lighting— so many channels for the electricity to travel, and they invited very much the greater part of the electricity to go into the working circuit. It was in order to provide against these faults that Mr. Brush set himself to invent his machine. He would read what Mr. Brush said about his object in doing so. Mr. Brush said:—"The object of my invention was the production of a dynamo-electric machine that would automatically maintain a substantially or sufficiently constant potential under varying amounts of work in its external or working circuit.

In other words, a dynamo that would be adapted automatically to operate normally a small quantity of work as well as a large quantity in its external circuit." The way he accomplished that object of automatic regulation was by combining the series and shunt principles together—by winding the magnets both with a series wire and with a shunt wire, so that in that way they got rid of the specific objections to other forms of winding separately used. In a series-shunt machine the series wire current went to the electric light, came back to the machine, went round the magnets and returned again into the armature. In the same way the current was bifurcated, and went by the shunt wire travelled to the magnets and returned to the armature. A great deal was said in the evidence about constant potential. It had been suggested that Brush did not appreciate constant potential. There was no doubt that constant potential had become of more importance since incandescent lighting came into vogue. Brush pointed out, and all the witnesses admitted, that his machine was an endeavour towards automatic regulation of a dynamo, and, of course, that led to the perfection of the means of obtaining constant potential. Although constant potential was not precisely the object he was aiming at—it was automatic regulation he wished to attain—it was proved to be practically attained very near approximation of constant potential.

Lord McLAREN: Is constant potential produced in consequence of the series-shunt arrangement always exciting the magnets uniformly?

Mr. JAMESON: No; proportionately to the work done.

Mr. JAMESON said he had now sufficiently described the general characteristics of these machines, and he would now proceed to point out the features of the Brush machine. Having shown the machine to the Bench, Mr. Jameson drew attention more particularly to the commutator. There was, first, an insulating hub made of wood or some other insulating material, the wires were brought into it and were brought up through little holes into electrical connection with the brass sub-segment, and through these were passed what were called detachably attached segments of copper in electrical connection again with the brass. These were screwed on by screws of a peculiar construction. They were screws which had more head than tail, and the head was a large long head, which went down through this segment, and the tail was screwed into a brass sub-segment beneath. The great advantage of the arrangement was this, that when this was worn away by constant friction with the brush, they could, without discharging the electrical connection, just unscrew this copper segment, take it off and put a new one in its place. That was one of the great advantages of the Brush invention.

Lord ADAM: That does not seem anything very marvellous.

Mr. JAMESON explained that it was a very convenient arrangement. The thing could be unscrewed with the greatest ease without being prised off with hammers and chisels.

Lord McLAREN: You just put a new surface on it.

Mr. JAMESON replied in the affirmative. He now went to the provisional specification of Hadden's patent of 1878. According to the specification the invention consisted in the construction and use of annular metal armatures grooved on their peripheries or sides, or both, and insulating partly or entirely from each other, also in constructing commutators cylindrical with an insulating hub or body, to which were attached metallic sub-segments placed in electrical connection with the general mechanism in which the commutator was employed, and metallic wearing segments detachably attached to said sub-segments. He submitted that there was a sufficient general description of the commutators of this machine, they were cylindrical and there was an arrangement tending to preserve their cylindricity in this that they had got nails of a peculiar kind—that they had got an arrangement without taking off the copper segments, so as to have the cylindricity of this constantly preserved with an insulating hub or body. That was obtained by means of large wires, which were insulated from each other and also insulated from the shaft. "To which are attached metallic sub-segments." These were segments placed in electrical connection with the general mechanism in which the commutator was employed. "Metallic wearing segments detachably attached to the sub-segments." These were attached in such a manner that they could be easily detached from each other by means of the screws. Dealing next with the final specification, Mr. Jameson referred their lordships to page 16, which set forth the following description:—"1. An annular armature consisting of two or more plates formed with grooved sides or peripheries, or both, and insulated entirely from each other, substantially as shown in division number two. 2. A commutator cylinder consisting of an insulating hub or body, to which are attached sub-segments placed in proper electrical connection with the general mechanism in which the commutator is employed, and wearing segments detachably attached to said sub-segments, substantially as shown in division three. 3. The combination of sub-segment, R, wearing segments, S or T, screws, K, substantially as and for the purposes shown in division three. 4. The commutator having metallic insulating segments, T, substantially as shown in division three. 5. A commutator having metallic insulating segments, T, attached to and forming part of the adjoining conducting segments, S, substantially as shown in division three. 6. A commutator having two conducting segments, S, two opposing ends of which said segments are separated by an intervening insulator, T, the other ends of said segments, while insulated from each other, being closely associated, and not provided with an insulator, T, substantially as shown in division three." The criticism made upon No. 2 was that it exceeded the whole of the provisional specification. In one sense it did so. The patentee gave a general description of the commutator, and then, as he must take every part of his invention in order that he might not be cut out by some person subsequently claiming part of it and omitting the rest, or claiming part of it and adding something to it, the patentee then went on to No. 6 to complete his claims under this head. He (Mr. Jameson) submitted that all these matters were properly and sufficiently foreshadowed in the provisional specification. No. 2 was a general description; No. 3 was a combination of the three parts of what made up the commutator; No. 4 was again just a single integer of the combination, viz., this insulating segment, T; No. 5 was an attachment to the insulator, T, so as to make it a conductor as well as an insulator. Now keeping in view that this invention was merely one of mechanical details and not of any electrical principle, this was a description of a particular commutator.

Lord McLAREN: How is this an insulating segment?

Mr. JAMESON: It comes between two segments which were in electrical connection with the bobbins, and had the effect of cutting the bobbin out at that particular point.

Lord McLAREN: So far as regards the bobbins, the part of the armature that was previously at work is no longer insulated from the next one?

Mr. JAMESON: It might be entirely detached altogether, in which case the only use of it would be to keep up the cylindrical form without having any detachment whatever. It did good in this way, that it presented a larger surface to get into the brush. It made a larger surface between the brush and the wire which was in connection with the electrical current. It was insulated with reference to the segments on either side, but it did not insulate with reference to segments to which it was attached. It had its advantage in this way. He did not say that it had great electrical advantages, but it had a larger surface, and it was more important in this way, that it pointed to make the machine special. Two rounds of copper, connected with each other, conduced to the rigidity of the whole commutator, and that, of course, was an advantage. Now it was said this was not properly fore-shadowed, and Lord Trayner had adopted that view. Well, first as regarded the commutator, Mr. Brush described his invention in the provisional specification in these terms: "In constructing commutators cylindrical with an insulating hub or body to which are attached metallic sub-segments placed in electrical connection with two wires with the general magnetism with which the commutator is employed, and wearing segments detachably attached to said sub-segments." He held there was nothing uncommon in a patentee claiming not only the combination of a great number of details, but also claiming one of these details by itself as a separate and independent claim; and if that was set forth in the provisional specification, the machine described as a whole did not put aside what he claimed for particular parts. He might claim any part of the whole or any intiger or any combination of two or more intigers of the whole with the view of preventing his patent being infringed. Lord Trayner seemed to have said that in the provisional specification they must not only generally describe the invention, which he understood was all that was required, but it must be done sufficiently to allow the invention to be known. The provisional specification was in order to secure a patentee's invention and then he got six months to perfect it and give a final specification. It was time given to him to perfect his invention and work out the details, and in working out the details he would find out what his invention was worth and would put in a claim for the patent, not only as a whole but also for parts of his invention.

Lord McLAREN: The thing Lord Trayner holds against seems to be an unimportant part of the final specification. It occurs to one that process in this case might be sisted to allow the Brush Company to disclaim this part, as was done in the case of Sir William Thomson.

The Lord PRESIDENT: Is that not too late now?

Mr. MURRAY: In Sir William Thomson's case the disclaimer was made before the judgment. It is a very arguable point whether it could be done now.

The Lord PRESIDENT: There is a good deal disclaimed already.

Mr. JAMESON: A good deal my Lord, the whole of the shunt arrangement was disclaimed, because at the date of this patent Mr. Brush did not know it had been patented at all. It turned out that something approaching shunt had been foreshadowed by Sir Chas. Wheatstone in a communication to the Royal Society.

Lord McLAREN: He now claims the shunt and series as what is known as compound winding.

Mr. JAMESON: That is so.

Mr. JAMESON proceeded to contend that the segment, T, was meant to be a conductor as well as an insulator, and was more mechanical than anything else. Lord Trayner in his judgment admitted that as a mechanical arrangement it was new and useful and not open to challenge. "But," his Lordship proceeded, "the pursuers maintain that the letters patent under reduction are rendered invalid by reason of the patentee claiming in his final specification (as amended and described) something with reference to this commutator as an invention, which is not foreshadowed in the provisional specification. The claim here referred to is the fourth which is in these terms, 'the commutator having metallic insulating segments, T, substantially as shown in division three.' It appears to be necessary, or at least desirable and advantageous, to cut the armature bobbins out of circuit when they are crossing the neutral or current reversing points of the magnetic field. To do this the continuity of the current conducting segments of the commutator has to be broken either by a mere space or by the insertion of some non-conducting material at the given point. The

cutting of the bobbins out of circuit was known and practised before the defender's patent, but it was not done before then by means of an insulated metal segment. The advantage which attaches to the defender's method is this, that the insulated segment being metal like the conducting segments, there is insured a certain uniformity of wear over the entire surface of the commutator, which could not be preserved where a softer material like wood was used, or where merely a space was left. I am not aware that prior to the defender's patent any insulating body, metal or otherwise, was ever used, in the construction of the commutator, for the purpose of cutting the bobbins out of circuit. The insulating segment, T, of the defender's patent was therefore a novelty, and its utility I do not understand to be disputed. But was it foreshadowed by the provisional specification? I think not. In the first place the defender's second claim seems to me to be co-extensive with the provisional specification (in so far as it relates to the commutator), so that there was nothing left to claim under another head. If all that was foreshadowed in the provisional specification is included in the second claim, then the fourth claim, unless regarded as mere repetition, which nobody suggests, is for something not there foreshadowed. Secondly, the provisional specification relates only to the construction of a cylindrical commutator, whereas one of the chief purposes of, and one of the main advantages to be derived from the insulating segment, T, is the preservation or maintenance of the cylindricity of the commutator, an object probably as important and as patentable as, but quite distinct from, the shape or mode of construction. Thirdly, the insulating segment, T, is not merely or necessarily a part of the cylindrical commutator having sub-segments with wearing segments detachably attached. It has, and is intended to have, a peculiar function which is not referred to in the provisional specification at all. Fourthly, it is said that the segment, T, is a part of the wearing segment, and therefore falls within the description of the provisional description; but I think this is not so. The wearing segment is an essential part of the defender's commutator; the segment, T, is not. It may be dispensed with altogether. I come, therefore, on this part of the case, to the conclusion that the patent sought to be reduced is invalid, in respect the invention claimed in the final specification is larger and different from that claimed in the provisional specification." Now, Mr. Jameson proceeded, in the specification Mr. Brush desired it to be understood that the insulator, T, need not of necessity be material. It was really a wrong construction of the patent altogether to take up this opinion in order to avoid their claim as to this insulator, T, because Mr. Brush did not claim the hub in which the T did not occur. But for the sake of publication he said that if anybody liked to construct a commutator like his, having the other elements or integers of his invention, but chose to leave out the segment, T, or to substitute for it a wooden segment, or something of that sort, he might do so if he chose. Mr. Brush secured by that that his invention should not be pirated. He did not claim the insulator, T, and it was an extraordinary construction of the patent to say that after having given notice of this to the world generally, that he was to be held as invalidating his own claim for T altogether. Mr. Jameson further quoted the evidence of Prof. Perry, Sir Wm. Thomson, Mr. Brush and Mr. Imray, and said that, of course, there were two views taken by witnesses upon the point, but he submitted that the sound view, taking that explanation as to the effect of the arrangement, was that Brush showed he intended to construct cylindrical commutators. Certainly he meant commutators which were cylindrical and which would preserve their cylindrical form by the various devices which he set forth. He thought that matter was really disposed of when one considered the objects of a provisional specification, and he referred the Court to one or two cases bearing upon the point. The first case was Newall *v.* Elliott (27, Law Journal, Common Pleas), the rubric of which stated that "the nature of an invention need only be described generally in a provisional specification, which need not go into details as to the manner in which the invention was to be carried out." The case was one in which the patent was for improvements in apparatus employed in laying down submarine electric telegraph wires; and it was said that the patentees had brought into their final specification certain rings which had not been mentioned in the provisional specification. Chief Justice Boyle said that "the object of a provisional specification was only to describe generally and fairly the nature of the invention and not to enter into all the minute details as to the manner in which it was carried out. Otherwise a provisional specification would require to be a full and complete specification. The statute itself clearly indicated the distinction, because it called the latter a complete specification, implying that the former was in some respects incomplete. Moreover, it indicated that a provisional specification was to describe the nature of the invention, and no more."

The LORD PRESIDENT: The relation of a provisional and a complete specification to one another will depend a good deal upon the subject matter of the patent. Suppose it is a patent for a mechanical contrivance, must not the provisional specification set out in a complete way what the contrivance is?

Mr. JAMESON: It must set it out in a general way.

The LORD PRESIDENT: If it is a mechanical contrivance, I do not know how you could set it out in a general way. You must put it in the provisional specification.

Lord MCLAREN: It is sometimes said that a provisional specification need not be so express as to enable an intelligent workman to make a machine from it.

Mr. JAMESON: It is only the completed specification that must do that. But he contended this was a description of a cylindrical commutator with an insulating hub and metallic sub-segments placed in connection with the general mechanism, and metallic wearing segments detachably attached to said sub-segments. Now these were metallic segments in all cases in which the claim was made. No doubt the inventor said he might dispense with part of his wearing segments, but that was plainly an invention. Now in II. Law Reports (Chancery Division) in Penn *v.* Biddy, Lord Chelmsford said, "it seemed clear that the object of a provisional specification was to describe the nature of the invention, not with minute peculiarity, but with sufficient precision and accuracy to inform the law officers what was the subject matter of the patent. It was not necessary that the provisional specification should describe the mode in which it was to be carried out. That was left to the complete specification. A provisional specification protected an invention for six months, and the object of that was to enable the patentee to perfect his patent, so that he might be in a position to describe in the complete specification the best manner of performing the invention.

Lord MCLAREN: I suppose it is necessary that a provisional specification should distinguish the invention from all other inventions?

Mr. JAMESON: I think so.

Mr. GRAHAM MURRAY: I may say that I do not think there is anything between us in the law. All that a provisional specification may do is to disclose the nature of the invention. But then if I can show that the final specification has got a different invention in it from the one in the completed specification, then the patent is invalid.

Mr. JAMESON said that in the case of Storer *v.* Tod, it was laid down that it was not intended in a provisional specification to obtain such a description of a thing as that any ordinary workman might make it: but it was only intended to disclose the invention in its rough state. In the more recent case in the Chancery Division—the United Telephone Company *v.* Harrison—it was held that the provisional specification did not cover the invention, because the provisional specification applied solely to the reproduction of sounds at a distance, and it was held that that did not describe the phonograph. Therefore the patent was held to be bad; but the distinction there was very great, because the nature of the invention was not foreshadowed.

Lord MCLAREN: I think Edison was allowed to correct it by disclaimer, and the patent was upheld.

Mr. JAMESON: I believe so.

The LORD PRESIDENT: You need not go further into the law, it is quite clear.

Mr. JAMESON said they submitted that every item of all these claims carrying out the construction of a cylindrical commutator with an insulating hub and metallic sub-segments and wearing segments, was clearly enough foreshadowed in that provisional specification. It did not matter if in perfecting that invention they said that some wearing segments might be attached to others in the adjoining part of the cylinder, or that a part of the wearing segments might be so arranged as to cut out the bobbins. They did not claim as an invention the cutting out of the bobbins, but they were claiming the invention of a commutator which was to be used in connection with a machine otherwise described, in which the cutting out of the bobbins was an object to be attained. Therefore they adapted that mechanical appliance to the machine in which they were to use it, but they did not claim the cutting out of the bobbins but simply claimed a cylindrical commutator and they introduced a certain form into it—these wearing segments—so as to meet the cylindrical requirements of the machine. That being so he submitted they were fairly within the provisional specification, and that it would be altogether too stringent a construction of the provisional specification to say that it did not fairly cover everything that was claimed in the completed specification. That concluded what he had to say upon the point of the commutators. He now came to the much larger and more important question, he thought, in every sense of the word—the question of the series-shunt winding. There were a number of anticipations alleged upon record but they were all narrowed down to the anticipation by that publication contained in Varley's specification, and the alleged public user by Varley's machine. Therefore he might confine their attention to an investigation into Varley's specification.

Lord MCLAREN: I suppose if Varley's specification be actually an anticipation it is not necessary to prove that the design there described was for use.

Mr. JAMESON: No; publication is sufficient; but then, he added, the law which had already been laid before the bench came in that for a completed specification there must be such a description as will enable a workman of ordinary skill to make a machine of the kind described; and they must remember in that particular investigation that they must not take a skilled workman of the present day, but a workman of ordinary skill of 1876, when Varley's specification was published. They must also bear in mind that if there were publications here, and that most important invention lay open to everybody, nothing was done from that day to this, except to make that particular machine, which was made upon Varley's own orders in the works of Siebe and Gorman, who were Varley's partners.

The LORD PRESIDENT: Suppose Varley's invention was only disclosed in the provisional specification, if that was earlier in date than yours, then you are not the person who first invented it.

Mr. JAMESON: That would be so.

The LORD PRESIDENT: It does not require a complete specification.

Mr. JAMESON: It is a complete specification, but I say it was not sufficient to enable a workman to make it.

The LORD PRESIDENT: Suppose it is complete. If that specification discloses fully the nature of the invention but does not sufficiently describe the method in which it is to be made to enable a workman of ordinary skill to make it, still you would not be the true inventor.

Mr. JAMESON: I think in law we would be entitled to the patent.

The LORD PRESIDENT: I don't think that.

Mr. JAMESON: Unless he published and used it.

The LORD PRESIDENT: He published it in the specification.

Mr. JAMESON: But it must be publication such as would enable a workman of ordinary skill to make it.

The LORD PRESIDENT: No. It is publication of the invention, that would be an anticipation of yours, although there is no description of how it is to be carried out.

Mr. JAMESON: I shall consider that point. I am not prepared at present to meet it.

The LORD PRESIDENT: I am afraid that is the law.

Lord MCLAREN: Otherwise the result would be that no one would have a patent unless it was sufficiently described to allow a workman to make it?

Lord ADAM: A great deal depends upon the nature of the invention.

Mr. JAMESON: A patent was really founded upon this principle, that every person who made an invention and got a patent for it should so describe it as that that invention shall be useful to the public.

The LORD PRESIDENT: That is essential to the validity of his patent, but he may be the first inventor although he has not got a good patent.

Lord MCLAREN: Compound winding seems to depend upon the mechanical contrivance by which it is effectuated. There might be many ways of doing it.

Mr. JAMESON said that was very important. Compound winding did not depend upon a number of wires being wound. It depended upon their connections and how they were wound.

Lord MCLAREN: Suppose a man had described a patent in his specification without giving details, would not that be a good patent?

Mr. JAMESON: Not unless it shows it to enable a workman of ordinary skill to make it.

The LORD PRESIDENT: I don't think that. Suppose a man had described an invention in a magazine which was read by the public?

Mr. JAMESON: That would be a different question. We are here upon a specification and upon nothing else. If persons are to get advantage of the publication in the specification, that must be complete.

The LORD PRESIDENT: What's your authority for that?

Mr. JAMESON: I shall endeavour to get that authority at a later stage.

The LORD PRESIDENT: There are many cases in which a man has lost his patent through defects in the specification, but he did not cease to be the inventor of the machine; and the question here is whether you or Varley was the first or true inventor.

Mr. JAMESON: Certainly, and we say that not only is there that wanting in the specification but really that Varley himself did not understand or invent this.

The LORD PRESIDENT: That, you are quite entitled to try to make out.

Mr. JAMESON said that at the time of Varley's specification in 1876 there had only been series and shunt winding, the machines then having separate modes of excitation, either inside or outside, drawn from a separate source. Shunt winding was hardly known. It had only been spoken of in the communication by Sir Charles Wheatstone, and that was in 1867, but that was hardly shunt winding. It was shunt in a fashion, but it might quite as well have been described as a short circuit series machine. But in 1879 Sir William Siemens took out a patent for shunt. That was the first time a patent was taken out for a shunt except by Brush, who afterwards disclaimed it in consequence of this communication by Wheatstone to the Royal Society. Therefore, in 1879, they had it in evidence that the shunt arrangement was not likely to be known to the world. The first time shunt machines were exhibited and were commercially successful was in 1861. They were shown at the Exhibition in that year and came into general use. Now he asked their Lordships to turn to Varley's specification. They might take it as admitted that Brush's specification clearly and distinctly set forth this compound winding. Their claim was, "In a dynamo-electric machine the wire or helix, E, having a comparatively high resistance and kept in close circuit while the machine is running, in combination with the magnetic wave or helix, F, as commonly employed, substantially as shown in division four." In his specification Hadden said, "My invention has for its object the maintenance in dynamo-electric machines of a 'magnetic field' while the machine is running, whether the external circuit is closed or open in dynamo-electric machines as ordinarily constructed. In dynamo-electric machines as ordinarily constructed no magnetic field is maintained when the external circuit is opened, except that due to residual magnetism, hence the electromotive force developed by the machine in this condition was very feeble. It is only when the external circuit is closed through a resistance not too large if powerful currents are developed, owing to the strong magnetic field produced by the circulation of the currents themselves around the field magnets. Such machines are not well adapted to certain kinds of works, notably that of electroplating. I attain my object by diverting from external work a portion of the current of the machine, and using it either alone or in connection with the rest of the current for working the field magnets." Now, turning to Varley's specification, Varley states: "This invention is an improvement on a previous invention for which provisional protection was granted to myself in conjunction with Cornelius Varley, bearing date the 24th December, 1866, but which was not proceeded with, and which invention was made the subject of a second application, and which letters patent were granted to us bearing date 15th June, 1867." Varley then went on to state that in the previous provisional specification, a method was described which might be said to have marked a new era in the construction of dynamo-electric machines used for producing the electric light. Nearly all the subsequent machines, Varley proceeded, which had been designed for this purpose depended for their action on the principle first described in the provisional specification. This principle consisted in causing electricity and magnetism, developed by the expenditure of mechanical force, to act and re-act on one another in the machine itself in such a way as to develop a greatly increased amount of both these forces. Such increased amount of magnetism and electricity, as was well understood, involved an increase in the consumption of mechanical force for giving motion to the machine. The development of electricity and magnetism, such as Varley described, Mr. Jameson contended was not at all the development which took place by winding coils to the magnets with wires through which the electric current was running, thereby increasing the magnetism. Mr. Varley said that his improvement consisted in separating the development of the electrical and magnetic forces to a considerable extent, obtaining thereby greatly increased magnetic potential in the bobbins, which, at a later stage, become converted into electricity of a correspondingly high potential. He effected this by what might be described as splitting up the bobbins. Mr. Varley did not confine himself to Faraday's discovery as to the electric current in the bobbins. But he talked about magnetism in the bobbins instead of in the magnets. He held this extraordinary notion that they might be three bobbins, in which case they would require to have three kinds of magnets, which was like a fifth wheel to a coach. There was no storing of electricity. It was most important for the Court to consider that this invention of Varley's described a particular machine for carrying out a principle which had nothing whatever to do with compound winding, and referring back to a machine in which the development of magnetism in the magnets was caused in a totally different way from that which Brush had patented. Mr. Jameson proceeded to criticise in detail the different clauses of Mr. Varley's specification, directing particular attention to the clause, "Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets, and the remaining portion is used to produce the electric light. There are several well-known ways of doing this, but the method I prefer is to wrap the soft iron magnets with two insulating wires, one having a larger resistance than the other—the circuit of larger resistance is always closed, and the circuit of less resistance is used for the electric light." Mr. Jameson said it might be that with their present state of knowledge Varley had described a series shunt, but the question was whether Varley understood what he was talking about, and was it described in such a way as that any person could understand it? Varley went on to describe a machine, and when they came to the end of his claims they found that there was no claim whatever made for this so-called invention.

Lord MCLAREN: He did not claim compound winding but perhaps he not claim it not because he did not understand it, but because he did not think it was new.

Mr. JAMESON replied that Varley made the excuse that he thought it had been anticipated by the invention described by his brother, between whom and himself feelings were very hostile. This brother, Cromwell Varley, read a paper to the Royal Society in which he described wire or sheet copper put round the magnets so as to preserve a certain amount of residual magnetism. But to close the reference to Varley's specification Mr. Jameson drew their Lordships' attention to the diagrams and stated that they would look in vain for any indication of a series-shunt winding machine. Mr. Jameson then went on to quote at considerable length from the evidence of Prof. Sylvanus P. Thompson as to the electrical absurdity of Mr. Varley's suggestions. Speaking with regard to Cromwell Varley's communication, Mr. Jameson said that Varley was put into the witness box and cross-examined as to why he did not claim this as an invention. His reply was that he did not claim it because of that communication of his brother Cromwell, with whom he was on very bad terms. That was very important, because it showed that he did not know that it was compound winding, or it showed that at best he had an exceedingly hazy notion of what he was thinking of. Now, if he had no clear conception of what he was recommending, and no clear conception of the effect of it, he would be very unlikely indeed to describe it in clear enough language to allow other people to understand it. Putting the case in the strongest view for the other side, what he said was that all Varley had was a very hazy and indistinct notion of winding the magnets with two wires and that he had no clear conception of how these would act, and how the machine was to be coupled up. Of course winding the magnet with two wires was no new invention; that had been done frequently before, but he had no distinct notion otherwise, and it would never have entered into his head that Cromwell Varley's patent was an anticipation.

The Court then adjourned for the day.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"The Treatment, Regulation, and Control of Electric Supply by the Legislature and the Board of Trade." By Major P. CARDEW, R.E., Member.

Mr. President and Gentlemen,—Before starting with the undertaking which in a moment of weakness I have laid upon myself, I have to ask a favour and convey a warning. The favour is, that you will bear in mind that nothing I may say to-night possesses any official sanction, or can be taken as in any way expressing the views of the Board of Trade.

Before preparing the paper I obtained permission from the Department under which I serve to do so; but some rather delicate ground is traversed in the paper, and I am sure I may rely upon your forbearance to-night, in any discussion which may arise, to avoid any questions of policy.

The warning is, that I am painfully conscious that the paper is very dry and portentously long.

The subject which I have the honour to submit to your notice to-night is the "Treatment, Regulation, and Control of Electric Supply by the Legislature and the Board of Trade." I am afraid the scientific interest of the paper is very small; but as many of you are practically concerned in the matters dealt with, I hope it will not be considered to be out of place.

The first attempt to deal with the question of electric supply on the part of the Legislature was the Act of 1882. As notice had been given of many private Bills to be brought in to acquire the necessary powers for a general supply, proceeding on very varying lines, it was thought that the time had come for a general Act dealing with the subject.

The two principal objects of this Act were—(1) to empower electric supply companies, or persons, or local authorities desirous of undertaking this supply for their own districts, to lay their mains in the public streets, and conduct the business of supply generally in a manner recognised by law; (2) to recover charges for supply made to consumers. At the same time proper regulations and conditions were imposed upon the undertakers to secure the safety of the public and the adequacy of the supply; while the fear of creating a new perpetual monopoly was evidently present in the minds of the framers of the Act.

This Act is so familiar that a short sketch of its provisions will be sufficient. It sets out by detailing the various ways in which statutory powers can be obtained. These are—(1) By licence, (2) by provisional order, (3) by special Act.

The issue of licenses is left entirely in the hands of the Board of Trade, but the consent of every local authority affected must first be obtained. The original period for which a licence is granted must not exceed seven years, but it may be renewed with the like consents. A licence may be for "public purposes" or "private purposes." "Public purposes" only allows supply for electric lighting of streets, public places, buildings, theatres, &c.; while "private purposes" allows general supply, not only for lighting, but for any other purpose, except the transmission of any telegram. The Board of Trade is empowered to make such regulations and conditions in a licence as it may think expedient.

Provisional orders in this Act may be granted without requiring the previous consent of the local authorities affected, but have no force unless and until confirmed by Act of Parliament. The period of an order may be limited, or it may be unlimited in duration. There appears to be very generally diffused a mistaken idea on this point. Many people appear to think that a provisional order only lasts for 42 years, or 21 years under the old Act. This was stated in the *Times* the other day as a fact. It is, however, quite a mistake. The orders granted by the Board of Trade, and confirmed by Parliament, have hitherto been, without exception, I think, unlimited in duration. There are various provisions for sale or transfer of the undertaking, including, in the case of a company, compulsory sale to the local authority; but these provisions may never be acted upon, and even if they are put in force, do not extinguish the powers granted.

Section 6, with respect to regulations, is so important, that it will be better to read the exact words—

"6. The undertakers shall be subject to such regulations and conditions as may be inserted in any licence, order, or special Act affecting their undertaking with regard to the following matters:

"(*a*) The limits within which, and the conditions under which a supply of electricity is to be compulsory or permissive;

"(*b*) The securing a regular and efficient supply of electricity:

"(*c*) The securing the safety of the public from personal injury, or from fire or otherwise;

"(*d*) The limitation of the prices to be charged in respect of the supply of electricity;

"(*e*) The authorising inspection and enquiry from time to time by the Board of Trade and the local authority;

"(*f*) The enforcement of the due performance of the duties of the undertakers in relation to the supply of electricity by the imposition of penalties or otherwise, and the revocation of the license, order, or special Act where the undertakers have, in the opinion of the Board of Trade, practically failed to carry the powers granted to them into effect within a reasonable time, or discontinued the exercise of such powers; and

"(*g*) Generally with regard to any other matters in connection with the undertakings.

"Provided always, that the Board of Trade may, from time to time, make such regulations as they may think expedient for securing the safety of the public from personal injury or from fire or otherwise, and may from time to time amend or repeal any regulations which may be contained in any such license, order, or special Act in relation thereto; and any regulations so made or amended by the Board of Trade shall, from and after the date thereof, have the like effect in every respect as though they had been originally inserted in the license, order, or special Act authorising the undertaking; and every regulation so repealed shall, from and after the date thereof, be repealed accordingly, but such repeal shall not affect any liability or penalty incurred in respect thereof prior to the date of such repeal, or any proceeding or remedy which might have been had in relation thereto.

"Any local authority within any part of whose district electricity is authorised to be supplied under any license, order, or special Act may, in addition to any regulations which may be made under the preceding provisions of this section for securing the safety of the public, from time to time make, rescind, alter, or repeal bye-laws for further securing such safety; and there may be annexed to any breach of such bye-laws such penalties, to be recovered in a summary manner, as they may think necessary: Provided always, that no such bye-laws shall have any force or effect unless and until they have been confirmed by the Board of Trade and published in such manner as the Board of Trade may direct."

The proviso enabling the Board of Trade to make regulations from time to time, and to amend or repeal any regulations, is certainly a wise provision, and, as you are aware, it has been largely carried into effect.

The power conferred upon the local authority of making bye-laws for further securing the safety of the public should also be noted, and that this may be exercised even where they are themselves the undertakers.

In the case of local authorities being undertakers, power is given for them to contract for the execution and maintenance of any works, or for the whole business of supply; but they are forbidden to transfer or divest themselves of any legal powers or liabilities without the consent of the Board of Trade.

As regards overhead wires, undertakers must get the express consent of the local authority for their erection along, over, or across any street, and the local authority may remove any electric line placed above ground without such consent, and, even where such consent has been given, a court of summary jurisdiction may order the removal of any electric line, on the ground of public safety.

It must be noticed, however, that nothing in this Act empowers any interference on the part of the Board of Trade or any other authority with electric lines erected by persons who are not undertakers. The undertakers are not allowed to prescribe any special form of lamp, or to interfere with the use made by any consumer of the supply given to him; but no consumer is to deal with his supply in such a manner as to unduly or improperly interfere with the supply to other consumers; and any dispute as to this is to be determined by arbitration.

There are provisions against undue preference on the part of the undertakers in their supply and charges. I take the meaning of these sections (19 and 20) to be this—that the undertakers may make any agreement as regards price, hours, of supply, &c., provided that the price is not in excess of the maximum rates laid down; but that, where they have made any such agreement with any private consumer, any other private consumer may demand a similar agreement, where the conditions are similar; and so in the case of street lighting authorities; but not that a private consumer could demand to be supplied at the same rate as is agreed upon for the street lighting or for lighting a large theatre.

Supply may be cut off for neglect of payment of charges due, but only until these charges and any expenses incurred in cutting off the supply are fully paid.

Any unlawful and malicious injury of electric lines and works is made a felony, and any person who maliciously or fraudulently abstracts, causes to be wasted or diverted, consumes or uses, electric energy is declared to be guilty of simple larceny—in fact, to have stolen it.

The purposes for which the officers of the undertakers may enter premises of consumers are strictly defined, and they have no legal right of entry for any other purpose—*e.g.*, to inspect the electric lines and fittings of the consumer.

The Board of Trade has, however, so framed the orders and safety regulations as to make it unlikely that any consumer would refuse entry to a properly authorised agent of the undertakers, if required by them to make an inspection of these electric lines and fittings.

In the section of the Act providing for the protection of the Postmaster-General, it is curious to note that a distance of 10 yards was apparently considered as the outside limit of distance within which a telegraph line might be affected by an electric supply line.

The section dealing with compulsory purchase by the local authority after 21 years has been made the scapegoat for the failure of the electric lighting "boom" of 1883. It is questionable, however, whether it had so much effect as is attributed to it in preventing capitalists from coming forward to support electric lighting schemes, and also whether whatever checking influence was really due to it has not in the long run been as beneficial as a nipping frost in early spring in restraining youthful impetuosity.

And I may remark that this clause did not excite any serious

opposition at the time; in fact, the Bill was sent up from the Commons with a 15 years limit, and extended in the Lords to 21 years, which was considered an ample time even by the persons best qualified to judge, as is amply demonstrated in the minutes of evidence given before the Parliamentary Committee.

In the amending Act of 1888 the first section has two important provisions—

"1. Notwithstanding anything in the Electric Lighting Act, 1882, no provisional order authorising the supply of electricity by any undertakers within the district of any local authority shall be granted by the Board of Trade except with the consent of such local authority, unless the Board of Trade, in any case in which the consent of such local authority is refused, are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with; and in such case they shall make a special report, stating the grounds upon which they have dispensed with such consent. The grant of authority to any undertakers to supply electricity within any area, whether granted by licence or by means of a provisional order, shall not in any way hinder or restrict the granting of a license or provisional order to the local authority, or to any other company or person within the same area."

The second section repeals section 27 of the former Act, and substitutes 42 years for 21 as the time to elapse before compulsory purchase can be enforced.

Section 3 gives power to the Board of Trade to vary the terms of compulsory sale in accordance with any agreement between the local authority and the undertakers.

Section 4 is very important, as it empowers the Board of Trade to make regulations for the protection of the public safety and of telegraphic and telephonic lines in the case of any electric lines used for the supply of electric energy, however laid or erected, and whether under statutory powers or not. Perhaps I had better read the first part of this section—

"4.—(1) Where in any case any electric line or other work may have been laid down or erected in, over, along, across, or under any street, for the purpose of supplying electricity, or may have been laid down or erected in any other position for such purpose in such a manner as not to be entirely enclosed within any building or buildings, or where any electric line or work so laid down or erected may be used for such purpose otherwise than under and subject to the provisions of a license, order, or special Act, the Board of Trade, if they think fit, may, by notice in writing under the hand of one of the secretaries or assistant secretaries of the Board of Trade, to be served upon the body or person owning or using or entitled to use such electric line or work, require that such electric line or work shall be continued and used only in accordance with such conditions, and subject to such regulations for the protection of the public safety and of the electric lines and works of the Postmaster-General, and of other electric lines and works lawfully placed in any position and used for telegraphic communication, as the Board of Trade may by or in pursuance of such notice prescribe; and in case of non-compliance with the said regulations, then the Board of Trade may require such body or person to remove such electric line or work: Provided that nothing in this sub-section shall apply to any electric line or work laid down or erected by any body or person for the supply of electricity generated upon any premises occupied by such body or person to any other part of such premises."

Sub-section (2) provides for the Postmaster-General taking action himself in the case of lines not laid under statutory powers, in the event of actual interference with his telegraphic lines provided that these lines are not already regulated by the Board of Trade. The general purport of the section is to place the responsibility for the proper regulation of electric supply wires generally on the Board of Trade.

We now come to the dealings of the Board of Trade with the subject, and I propose to consider in the first place the various forms of provisional orders granted under the general Acts. As licenses differ very slightly in form from orders of the same date, it will not be necessary to discuss them.

There are up to the present time four forms of orders, differing materially from each other in important respects, and showing, I consider, progressive improvement in the treatment of the subject as experience was gained.

These are—1st. The 1883 form, of which Bradford is, I think, the only one now actually being worked, but some other local authorities are preparing to start under old orders; 2nd. The Chelsea order of 1886, and St. Austell license of 1885; 3rd. The London orders of last year, which form, I may point out, is only applicable to metropolitan districts under the London County Council; 4th. The model forms of Orders for this year, which are even now being modified in certain clauses, and will not attain finality until some points have been determined by the action of Parliament.

There are slight variations in form among individual orders, generally due to some local considerations, and in every case there are considerable differences between orders granted to local authorities and those granted to companies.

The first matter in all the orders is the interpretation clause. In this, last year an innovation very important to electricians was introduced, viz., the definitions of "energy" and "power"—

"The expression 'energy' shall mean electrical energy, and for the purposes of applying the provisions of the principal Act to this order electrical energy shall be deemed to be an agency within the meaning of electricity as defined in the Electric Lighting Act of 1882."

And

"The expression 'power' shall mean electrical power, or the rate per unit of time at which energy is supplied."

They hang upon the definition of electricity in the principal Act as "electricity, electric current, or any like agency." Rather a general definition, you see.

Now, the use of the term "energy" has, I consider, materially improved the language of the orders, both from a scientific and a legal point of view. Under the old forms of orders the undertakers were authorised to supply "electricity," and continual reference is made to this as the quantity supplied. Now, this word has, or had, many meanings, but in this case it it could only mean electrical energy. But when we turn to the "price" clauses we find that energy is expressly mentioned as differing from electricity, and that there, at all events, the latter meant what we now call "electrical quantity." There really was here some confusion of language, distressing to the electrician, and opening up grand possibilities of endless talk to lawyers. The proposed amendment was referred to your Council and concurred in by them, and I am glad to notice that the use of the term "electrical energy" is gradually working its way.

I am not yet satisfied, however, with our word for what used to be the particular meaning of electricity. It is rather absurd to call it "electrical quantity," since so many other things are electrical quantities. I almost think we want a word for this even more urgently than for electrical locomotion, over which so much ingenuity has been lately expended. The worst of it is that, as nobody knows what it is, or to what extent its existence is an objective reality, it is difficult to find an appropriate word. At any rate, it was impossible in the orders to call it "electricity" any longer, as the Act says that is what is to be supplied; so that we had to define "energy" as what was meant by electricity in the Act, and use "electrical quantity" for the particular meaning for want of a better word.

This also necessitated an alteration in the title. There is a slight further alteration in the new model title.

As regards the definition of "power," this was necessary to avoid a difficulty in modifying a few clauses in the old orders which dealt with the maximum current to any consumer to render them applicable to transformer systems.

The definition of "main" has been materially altered. Thus it used to mean the conductor alone, then a continuous electric line, defined in the Act as follows:—

"The expression 'electric line' means a wire or wires, conductor, or other means used for the purpose of conveying, transmitting, or distributing electricity with any casing, coating, covering, tube, pipe, or insulator enclosing, surrounding or supporting the same, or any part thereof, or any apparatus connected therewith for the purpose of conveying, transmitting, or distributing electricity or electric currents."

And, lastly, the word "continuous" has been omitted as unnecessary in the case of transformer systems.

The definition of "service line" has been altered in the same way.

"Distributing main" has not been altered. It is a very important definition, which I will read:—

"The expression 'distributing main' shall mean the portion of any main which is used for the purpose of giving origin to service lines for the purpose of general supply."

Difficulties may arise in interpreting this, as, for instance, in cases where the same conductor is at one part a feeder and at another a distributing main; but it is one of those things which must be left to custom and precedent.

The other definitions need not detain us now, except that two important ones have been added in the new forms:—

"The expression 'consumer' shall mean any body or person supplied or entitled to be supplied with energy by the undertakers.

"The expression 'consumer's terminals' shall mean the ends of the electric lines situate upon any consumer's premises and belonging to him, at which the supply of energy is delivered from the service lines."

The consumer's terminals are the point of demarcation between the possessions of the undertakers and their customers; they need not be binding posts.

In the clauses headed "area of supply," an important novelty was introduced last year, and has been retained in the new model for companies, expressly prohibiting the undertakers from supplying outside the area granted to them without further statutory powers. This is a sacrifice of their common law rights which they are required to make in consideration of the special privileges they acquire. You are perhaps aware that this provision is being carried out by mutual agreements between the London companies.

The old orders, and the Liverpool and Swansea orders of last year, provided for the division of the whole area into two districts, scheduled A and B respectively; the A district alone being the area for which powers are immediately granted, and in which supply is compulsory; while the B district was intended to be added piece by piece, practically at the option of the undertakers.

The general effect of this was to induce undertakers to apply for very large districts, the greater part of which were in the B schedules, over which they thereby acquired a sort of prior right of occupation without incurring any liability. This was altered last year, and a single district substituted, to the whole of which the "Compulsory Works'" clauses apply.

(To be concluded.)

Physical Society.—May 16th, 1890.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

Prof. W. Coleman was elected a member of the Society.

Lord RAYLEIGH exhibited and described an arrangement of "Huyghens' Gearing in illustration of Electric Induction." This gearing consists of two loose pulleys mounted on the same axle, with an endless cord laid over them, the loops or bights of which carry weighted pulleys whose planes are parallel to the axis on which the upper pulleys turn. If one of the latter pulleys be started to rotate, the other one turns in the opposite direction until such time as the speed of rotation of the first one becomes constant. Whilst this constant speed is maintained the second pulley remains stationary, one weight being raised and the other lowered, but on retarding the motion of the first pulley the second commences to turn in the same direction as the first. It will be noticed that the phenomena are analogous to those which occur in electric induction where starting or increasing a current in one circuit induces an opposite current in a neighbouring circuit, whilst decreasing or stopping a current induces one in its own direction. Lord Rayleigh pointed out that in this apparatus there is nothing strictly analogous to electric resistance, for the friction does not follow the same law. The analogy, he said, was complete as regards there being no change of potential energy, and the mathematical equations for the kinetic energy of the system are precisely the same as those given by Maxwell for electric induction.

NEW PATENTS - 1890.

7378. "Improvements in electrical switches." A. BRULL. Dated May 12.

7399. "Improvements in heating by magnetism and electricity." R. KENNEDY. Dated May 13.

7422. "Improvements in appliances used for protecting or regulating an electrical circuit." F. BRYAN. Dated May 13.

7425. "Improvements in the method of producing alternating electric currents." M. S. CONLY. Dated May 13. (*Complete.*)

7436. "Improvements in switches for electric currents." B. DUKES. (Communicated by C. F. R. Bosse, Germany.) Dated May 13.

7456. "Apparatus for applying electricity to produce water-pressure for fire extinction or like purposes." A. DE BROUCHERE and L. ANSPACH. Dated May 13.

7505. "New or improved safety devices for use with strong tensional electric currents for lessening fire risks." A. L. TAYLOR. Dated May 14.

7513. "Improvements in the manufacture of electrodes for secondary batteries." W. L. WISE. (Communicated by P. Schoon, Switzerland.) Dated May 14.

7520. "A method of signalling on electric lighting circuits." W. C. JOHNSON and S. E. PHILLIPS. Dated May 14.

7540. "Improvements in electric arc lamps." W. L. WISE. (Communicated by La Société Japy Freres, France.) Dated May 14.

7599. "Improvements in electric arc lamps." R. BELFIELD. (Communicated by P. Lange, United Stated.) Dated May 15.

7618. "Improved electrical device for use in dental operations." J. P. BAYLY. (Communicated by C. W. Manker, United States.) Dated May 16.

7670. "Electric Meter." C. D. ABEL. (Communicated by La Société Anonyme Continentale, France.) Dated May 16.

7674. "Improvements in the manufacture of glass shades for electric lamps." J. A. JOBLING. Dated May 16.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

5063. "Improvements in instruments for the measurement of electric currents and electromotive force." E. H. HUNGERBUHLER and J. T. TODMAN. Dated March 23. 8d. Claims:—1. The combination in or with a portable instrument for measurement of current or electromotive force of a taper soft iron core, pivoted centrally, so as to move freely within the curved bobbin of a solenoid, round the coils of which the current to be measured flows, the pointer secured to the pivot with the volute or concentric spring and counterbalance, and the buffer springs attached to the core, all combined and operating together for the purposes set forth. 2. The combination in or with a portable instrument for measurement of electric current or electromotive force of the particular construction and arrangement of binding screws or terminals, operating as described.

5867. "Improvements in connection with switches for telephone circuits." A. GRAHAM. Dated April 5. 8d. The inventor causes the release of the contact maker by means of the telephone receiver when it is put in place after use. For this purpose he provides a receiver holder or support, consisting of a forked lever or the like, by which the receiver is supported, its weight bringing the said lever into one position, whilst a spring or its equivalent brings the said lever into another position when the receiver is removed. In connection with this lever he provides a spring or other device, which, when the receiver is removed, takes up a position such that when the receiver is again put in place, the said spring or device operates the detent or retaining device by which the contact maker has been held in position for use, so that the said contact maker returns to its normal position of zero, the movement of the said contact piece in returning to that position effecting the return of the aforesaid spring or device to a position which allows the detent or retaining device of the contact maker to operate to retain the said contact maker in the position to which it may be brought when the said contact piece is again operated for completing any desired circuit. 3 claims.

CORRESPONDENCE.

The Jarman System of Electric Traction.

The attention of my directors has been called to an article on the above in your paper of 30th May. Whilst this able article deals in a manner to which no exception can be taken with the merits of the Jarman system, I am instructed to say that the statement therein contained as to any arrangements having been made with the London Tramway Company is not a fact, nay, more, no negociations for any arrangement has even been initiated with that company. I shall be obliged by your informing me from whom you obtained this erroneous information, and also by your inserting this letter in your next issue.

Electric Tramcar Syndicate,
JAMES WHITE, *Secretary.*

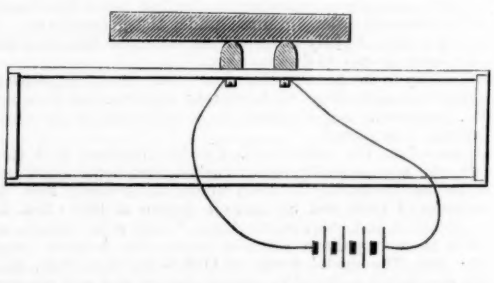
London, *June 4th*, 1890.

[The writer of the article begs to refer our correspondent to Mr. Jarman himself.—EDS. ELEC. REV.]

Buzzing in Telephones.

If a microphone be delicately adjusted and mounted on a resonating box, it will be set into continuous vibration when a sufficiently strong current is sent through it.

In the experiment, the fixed carbon pieces were small blocks with rounded contact surfaces. The vibrators were of square or oblong section, in some cases grooved below, so as to form two points of contact where resting on the fixed blocks.



The time of vibration varied, of course, with the particular vibrator employed; but, by suitably choosing these, almost any rate could be attained from a steady sway from side to side with the heavier ones, to a decided "buzz" when a slender rod was used.

There is no doubt that the motion is a Trevelyan-rocker effect. The "buzzing" is similar to that heard in a telephone when in circuit with a faulty transmitter, and this latter nuisance is probably, in part at least, produced in the same way.

R. Appleyard.